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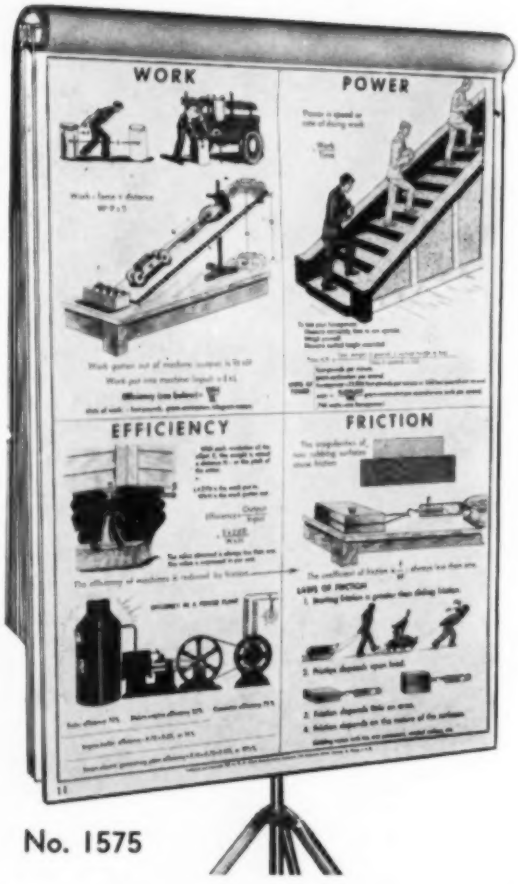

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Writing for Publication

Thought, energy and care go into the writing of a paper for publication, even a brief and simple paper. But the author is well compensated, even though he receives no financial remuneration for his work.

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Which article in this number helped or interested you most?

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H. C. M., 1946

Temperature and Precipitation as Contributing Factors in the Maturation of Peas

• **By Gerard W. Ostheimer**
ST. FRANCIS COLLEGE, LORETTO, PENNSYLVANIA

This paper was presented at the 1960 Annual Meeting of the Pennsylvania Round Table of Science, Duquesne University, April 2, 1960.

Mr. Ostheimer is a senior in St. Francis College.

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During the summer of 1959, I was the recipient of a National Science Foundation fellowship for summer research at Cornell University. The program was under the direction of Dr. G. C. Kent of the Department of Plant Pathology and my supervising professor was Dr. M. T. Vittum, Department of Vegetable Crops, New York State Agricultural Experiment Station, Geneva, New York. Under the guidance of Dr. M. T. Vittum, and his associates, Dr. G. Marx and Dr. N. Peck, I selected my summer research topic and proceeded to formulate the data and information I am privileged to present here.

The New York State Agricultural Experiment Station, a division of the New York State College of Agriculture, was founded in 1882. It is located in the Finger Lakes region of western New York and is in a rich and fertile atricultural area, where many varieties of vegetables and fruits are grown. This setting has been the birthplace of countless new varieties of vegetables and fruits since the station began.

Science has systematized agriculture more and more with each passing year, and, through analysis and research, definite methods of determining and predicting harvest dates have come into existence. One such method is the heat unit or degree day system of forecasting the maturing rate of peas. The maturity of peas can be forecast quite accurately by heat units, which are defined as the amount of daily average temperature above 40°F.

Our working formula is: Heat Units = Daily average temperature (maximum temperature + minimum temperature) ÷ 2 − 40°F. Only temperatures above 40°F. are considered as contributing to the growth of peas, thus 40°F. is the base temperature. It is believed that below 40°F., the pea plant will carry on only those processes necessary to maintain life. When the average daily temperature is less than 40°F., the value for the heat units for that day is zero and not a negative number. The two formulas and an example of each:

1) H.U. = MT − 40°F. when MT > 40°F.

2) H.U. = 0 when MT < 40°F.
H.U.—Heat Units MT—Mean Daily Temperature

(1) Max. temp.—94°
Min. temp.—56°

$$2 \overline{)\,150}$$

75°
−40°

35 heat units

(2) Max. temp.—46°
Min. temp.—28°

$$2 \overline{)\,74}$$

37°
−40°

0 heat units

In growing peas for freezing and canning, the grower is concerned with the highest market value possible for his crop. This will be the result of proper spacing in the planting dates of different fields of peas, so that they will not all mature on the same day.

Heat units are useful in scheduling plantings of peas. Theoretically, if the plantings were all on the same day, the freezing variety of one type of pea may all mature on the same day and the canning variety likewise may all mature at the same time a few days later. This presents harvesting and preserving problems which can be solved by staggering planting dates so that the different varieties will mature on successive days and can be harvested; thus giving the grower the best yields and tenderest peas which, in turn, gives the grower the best market value for his crop. Heat units help to determine when the farmer will do his planting and harvesting.

The heat unit system is given an assist in the determination of the maturity of peas by a machine called a tenderometer. This instrument is used to measure the tenderness of a specific volume of peas by physical force. The higher the tenderometer reading, the more mature and tougher are the shelled peas. A freezing variety at the time of harvesting should have a tenderometer reading of 85 to 95 and a canning variety 100 to 110. The reason for the difference is that the different methods of preserving used affect the peas and thus there is a necessity of having a certain age for each type of pea.

Our experiments included several varieties of peas and different cultural conditions, such as irrigation versus non-irrigation and heavy fertilization versus light fertilization. Field plots were randomized in a split-split plot design with 7 varieties × 2 fertility levels × 2 irrigation treatments (irrigated and non-irrigated) × 3 replications = 84 plots.

A definite number of heat units is required for each variety of pea. We shall limit our discussion to Perfection, a common variety of pea grown both for its freezing and canning qualities. The Perfected Freezer variety averages 1500 heat units, whereas Perfection, a canning variety, requires approximately 1600 heat units.

The following chart gives the history of Perfection peas grown in one experiment at Geneva from 1952–1959.

As can be gathered from the table, peas were usually planted during the last two weeks of April and were harvested during the first two weeks of July. Heat units for the growing season ranged from 1450 to 1600 with a few exceptions. A 150 heat units is equal to approximately five days in the months of July and August, when about 30 heat units are accumulated per day on the average. Temperature usually exerts the greater influence on the maturing rate of peas. Why then, did it require 88 days for growth during the 1958 season and only 65 days in 1954, when the heat units totaled 1593 in 1958 and 1550 in 1954, giving us a theoretical difference of one day? The answer: precipitation, naturally as rain, or artificially as irrigation. In 1958, 13.93 inches of rain fell, while in 1954, there was only 5.24 inches.

In what other ways was the crop affected? The yields varied widely in the two years. In 1958, non-irrigated normal fertility plots averaged 4020 lbs. of peas per acre, whereas, under the same conditions in 1954, 2610 lbs. of peas per acre were produced. The irrigated normal fertility plots produced less peas per acre when harvested within the same twenty-four hours because irrigation causes a slower maturing rate which directly affects the yield.

After a series of experiments, it has been proved conclusively that:

1) Irrigation extends the growing season according to the amount of water applied.
2) Precipitation, either natural or artificial, is now believed to be the key to the success of a pea crop and the length of the growing season.
3) It appears that if sufficient precipitation precedes flower bloom on the pea plant, an excellent yield can be expected.

The aim of my summer work was to try to establish a correlation between the effects of heat units and precipitation on the yield, maturing rate, and quality of the pea produced. At present, it appears that yield and quality are both closely related to the amount of temperature and rainfall which occurs prior to bloom.

If, by further study and research, a definite relationship can be established between the two factors, it will enable the growers to systematize further the forecasting the maturity of their peas, thus eliminating more of the guess work in pea production.

Non-Irrigated — PERFECTION PEAS — (1959–1952)

Year	Plant Date	Harvest Date	Days of Growth	Growing Degree Days	Rainfall (Inches)	Irrigation Applied	Total Water	Yield acre NF[1]	per (lbs.) HF[2]	Tenderometer NF[1]	Tenderometer HF[2]
1959	4/25	7/4	70	1533.	7.14	—	7.14	2062.	2133.	96.4	95.4
1958	4/17	7/14	88	1593.	13.93	—	13.93	4020.	3260.	130.2	124.7
1957	5/1	7/6	66	1450.	7.52	—	7.52	3960.	4555.	114.5	121.2
1955	4/13	6/29	77	1534.	3.54	—	3.54	3250.	3640.	109.	101.
1954	5/13	7/17	65	1550.	5.24	—	5.24	2610.	2510.	99.	100.
1953	4/16	7/7	82	1601.	7.68	—	7.68	4540.	4647.	114.3	119.3
1952	4/19	7/4	76	1616.	7.02	—	7.02	4597.	5027.	110.	107.
*Irrigated**											
1959	4/25	7/7	73	1619.	7.64	3.68	11.32	1184.	1412.	98.4	102.2
1958	4/17	7/5	89	1625.	13.93	2.93	16.86	3870.	3270.	143.3	133.6
1957	5/1	7/6	66	1450.	7.52	1.76	9.28	3320.	3700.	102.	106.6
1955	4/13	7/6	84	1800.	3.69	5.14	8.83	7160.	7020.	149.	176.
1954	5/13	7/17	65	1550.	5.24	2.35	7.59	2180.	2050.	87.	91.
1953	4/16	7/7	82	1601.	7.68	1.79	9.47	6220.	5329.	128.3	128.0
1952	4/19	7/4	76	1616.	7.02	2.54	9.56	4910.	4910.	102.	100.

* Irrigation applied when soil moisture content dropped below 50% of total available moisture capacity.

[1] NF—Normal Fertility [2] HF—High Fertility.

An Introduction to Zirconium Metal

• **By John D. Roach, M.S.** *(Rensselaer Polytechnic Institute)*
TITANIUM ALLOY MANUFACTURING DIVISION, NATIONAL LEAD COMPANY, NIAGARA FALLS, NEW YORK

In a comparatively short time zirconium metal has risen from the obscurity of rare elements to become one of the many useful engineering products of the metal industry. This spectacular rise is the result of concentrated efforts by the metal industry in the development of reduction, refining, melting and fabricating techniques fostered primarily by the desirable nuclear properties of this metal. The low neutron absorption cross section of hafnium-free zirconium accompanied by its favorable strength and corrosion resistance provides an extremely desirable engineering material for many applications in the nuclear energy program. The excellent corrosion resistant properties of this metal also make it attractive as a material of construction in the chemical industry. The purpose of this article is to briefly review the history, production and uses of this comparatively new metal.

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History

Zirconium is reported (1) to have been discovered in 1789 by Klaproth, who found a new oxide in a mineral from Ceylon, and originally gave it that name. Now, of course, the name is applied only to the metal, the oxide being called zirconia. The name is supposed to have been derived from the term "jargon", a Persian work meaning "gold-colored" which was applied to zircon gems from Ceylon. Berzelius in 1824 first prepared the metal, though probably in a contaminated form, by reducing potassium fluozirconate with potassium. It was not until 1923 that the universal association of another element, hafnium, with zirconium was discovered by Coster and Hevesy through X-ray examinations. The name of this element was derived from "Hafniae", the name given by the Romans to the settlement where Copenhagen is now located (2).

Before the first World War, 1914 to 1918, zirconium in any form was used only experimentally in Europe. As early as 1910, however, the possible use of Brazilian zirconia ore as a refractory material for crucibles was mentioned in America (3). By 1920, the Florida sands containing zircon were being treated to concentrate this mineral, and the use of the oxide as an opacifier for enamels, and of the metal (as a ferroalloy) for treating steel and other alloys, had been initiated. The extensive use of zirconium in American metallurgy was introduced by Becket in 1923 (4) who then reported the results of experiments undertaken largely to check a report that the Germans had developed a superior ordnance steel containing zirconium. Although the reports of the great superiority of this steel were not confirmed by American data, this work was the basis for many investigations of the effects of zirconium on steel and other alloys, and resulted in considerable usage of zirconium alloys as deoxidizers and addition agents.

Although the production of "pure" zirconium metal was described as early as 1920 (5), it was not until the development of the Van Arkel process of iodide decomposition in 1925 at Leyden, Holland, that pure, coherent metal became readily available for testing (6). The purest and most ductile zirconium available today is made by that process, but it is an expensive process and not suitable for quantity production. Furthermore, its product is a metal of low strength. A process more amenable to operation on a larger scale is that of Kroll and his collaborators in the U.S. Bureau of Mines, who reduce zirconium tetrachloride with magnesium to form magnesium chloride and zirconium metal (7). It was the development of this reduction process which opened the door to the economical production of zirconium in quantity.

Ore Supply

Although zirconium has been considered until quite recently as one of the rare metals, its ores are widely distributed, and its occurrence in the earth's crust compares favorably in a quantitative sense with that of many better-known metals. For instance whereas the earth's crust is estimated as 59.09% silicon and 1.05% titanium, the percentage of zirconium in it appears to be about 0.04% (2), this being more than the combined values for copper, lead, zinc, tin, nickel and mercury (8).

Practically all the zirconium used in American industry comes from the three extensive ore deposits in Florida, Australia, and Brazil. The first two consist of sea-coast sands from which zircon (zirconium silicate), along with other heavy minerals such as rutile and ilmenite, is readily separated by hydraulic classification. Thus, even though the ore is lean, the concentration is less costly than if drilling, blasting and crushing were also required. In Brazil, the chief zirconium ore is Baddeleyite, an impure oxide with less silica than is contained in zircon. Although in the past large tonnages have been imported from Brazil, over 15,000 tons for instance in 1942, at present this is a less important source of zirconium than Florida. In 1957 the zircon production from Florida only amounted to 56,802 short tons (9). Prospects for continuous operation at an expanding output are known to be excellent.

In Australia, the output has been reported as even higher, but less of this ore is reaching this country than formerly. Deposits of zircon have also been operated profitably in Madagascar and India, and in this country there are deposits in Oregon and North Carolina that could be worked if necessary. Thus sufficient ore is certainly available to fill any reasonably expected demand for the metal.

Methods of Manufacture

The zirconium originally made available for experimental use in a coherent ductile form was refined from a crude metallic powder produced by reduction either of zirconium oxide by calcium, or of the tetrachloride by sodium, or of potassium fluozirconate by potassium (1). Such powders were often of very low purity, analyzing only 80 to 85% zirconium. They

were converted to ductile metal bars by a refining operation, known as the Van Arkel-de Boer process, involving the formation and decomposition of zirconium tetraiodide in an air-free vessel. Iodine vapor in this vessel attacks the crude powder at a moderate temperature, and the tetraiodide formed is decomposed at a higher temperature. By causing the deposition to occur on a wire heated by an electric current a rod of zirconium crystals is built up, and the iodine released by decomposition of the tetraiodide then reacts with more of the crude zirconium in a cooler part of the vessel, repeating the process until all the crude zirconium is used up or the rod of refined zirconium becomes so thick that it can no longer be kept at the required temperature by the electric current available. Scrap metal or impure sponge, as well as powder, may be used as the raw material in this process.

A serious limitation of the process is the very heavy electric current necessary to maintain a thick zirconium bar at the temperature required for decomposition of the iodide, which is about 1300°C (2370°F) (10). Thus only fairly thin bars can ordinarily be made. The starting wire, generally tungsten, remains inside the bar as an impurity, but this objection can be overcome by using a zirconium wire to start the process.

Pure zirconium bars produced by the iodide process are not only necessarily small and very costly, but for engineering uses the metal in this form is comparatively unattractive because of its low strength (11).

Because it is more economical and also more adaptable to large scale production, the magnesium reduction of zirconium tetrachloride, the Kroll Process, is the most widely used method of zirconium production. By this method the ore is first treated in an arc furnace to convert the silicate to a carbo-nitride or "cyanonitride" which is chlorinated to obtain the tetrachloride. If high purity hafnium-free material, as required by nuclear applications, is desired, the tetrachloride is treated in a separation and purification plant to remove the hafnium and the resultant high purity oxide is rechlorinated to the tetrachloride. The latter is then reduced to metal by magnesium in a closed retort. Extreme care is required in the later stages of this process to avoid contamination of the metal by oxygen and nitrogen of the air. The metal is produced in the form of a gray crystalline sponge which is consolidated into ingots by arc melting in a water cooled copper crucible. A carefully controlled atmosphere, free from oxygen and nitrogen, is of course essential for melting operations.

Zirconium ingots can be readily fabricated with equipment normally used for other metals. Forging or hot rolling is accomplished at temperatures of 1350 to 1500°F where scaling and oxygen absorption is insufficient to affect the quality of the product. Cold rolling results in an increase in strength and hardness and a rapid decrease in ductility so that intermediate annealing treatments at approximately 1400°F are necessary to restore ductility. Heat treating down to thicknesses of approximately 0.050" may be done in air with subsequent scale removal by blasting and pickling. For thinner gages, an inert atmosphere or vacuum is recommended for any heat treating operation.

Uses

The earliest use to which zirconium metal was applied was for priming explosives and flashlight powders (1). Twenty-five years ago it was produced chiefly as a powder, and the extreme combustibility of this powder makes it very suitable for such a use. It also produces a very bright light when ignited. A similar use was as a getter for radio tubes (1), as the reactivity of finely divided zirconium renders it very effective for combining with the last traces of oxygen and nitrogen in evacuated vessels or tubes, thus removing these gases completely from the interior atmosphere.

These uses are still existent, and others are coming into prominence as the metal becomes more available. Among the promising applications that have been suggested are the construction of grid wires in vacuum tubes (12) and parts of discharge tubes exposed to high temperatures (13), as an electrolytic condenser for rectifiers (14), and in high intensity electric lamp filaments and electrodes in fluorescent tubes (15). Alloying uses are of course numerous, but are outside the scope of the present discussion.

The principal use of zirconium, however, and the primary reason for its rapid rise, is in the atomic energy program where its unique combination of nuclear, chemical and mechanical properties makes zirconium an ideal structural material for atomic reactors. Zirconium is used to clad nuclear fuel elements and as a structural material in reactors because of the following properties: 1.) low neutron absorption cross section; 2.) outstanding corrosion resistance and 3.) good physical properties. The low cross section of zirconium, 0.18 barns, means that this metal will absorb very few neutrons and thus permits efficient utilization of the nuclear fuel. On the other hand, hafnium, which is normally found in zirconium, absorbs neutrons readily, cross section 115 barns. It is essential for nuclear applications, therefore, that the hafnium content of the zirconium be maintained as low as possible. The hafnium content of reactor grade material is less than 200 parts per million while commercial zirconium usually contains approximately 2% hafnium. To overcome the harmful effects of minor impurities in zirconium intended for nuclear applications involving corrosion resistance to high pressure, high temperature water, Zircaloy 2 was developed. This zirconium-base alloy containing 1.5% tin and minor amounts of iron, chromium and nickel also has the strength required for moderately high operating temperatures. Nearly all the zirconium currently used in nuclear applications is employed as Zircaloy 2.

The principal use of commercially pure zirconium will probably be in the chemical industries or other applications where extremely high corrosion resistance is essential. In locations where corrosive media are involved and where increased service life and reduction of maintenance costs are desired, zirconium offers many advantages as a material of construction. Zirconium exhibits unusual resistance to corrosion by most of the organic acids and metal chlorides. It is extremely resistant to sea water and sea atmospheres. It also has good resistance to attack by strong alkalies, in which respect it surpasses tantalum. Because of its excellent resistance to nearly all forms of corrosion, commercial zirconium

(*Continued on Page 124*)

The Mechanisms of Replication in Virus

• **By Sister Carl Marie LiBrizzi, O.P.B.S.** *(Siena Heights College)*
BIOLOGY TEACHER, ST. PAUL'S HIGH SCHOOL, GROSSE POINTE FARMS, MICHIGAN

The purpose of this paper is to compare the mechanisms of self-duplication, as far as they are known, in viruses which infect bacteria, plant and animal cells, to note the similarities and differences in these processes and the effects they produce in the host.

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A system is said to be self-replicating if its structure is necessary for its own replication; i.e., it is not made in the absence of pre-existing forms of the same kind. Another necessary characteristic is that it can give rise to a mutated form capable of self-replication in the new form. This is not only a quality of multi-cellular animals or of cells, but is found in many sub-cellular systems; e.g., the chromosomes and even the gene. Evidence from electron microscopy has shown that even these contain linked sub-elements that can change.[1]

The ultimate unit of self-replication seems to defy identification. That deoxyribose nucleic acid (DNA) is strongly implicated in this process is shown by the work of Benzer[2] who found that genetic information in bacteriophage is carried by DNA and the ultimate unit of recombination appears to be a nucleotide (a gene, in turn consists of some 100 pairs of these nucleotides.) It appears that the polynucleotide, DNA, must have a definite sequence with respect to the individual polynucleotides comprising it and secondly the DNA exists as a two strand coiled molecule wherein one polynucleotide is hydrogen-bonded to its partner polynucleotide.[3]

The model for the structure of DNA given by Watson and Crick provided the first self-duplicating pattern which could function in its own duplication. Crick shows how a nucleic acid pattern can also determine the structure of other dependent patterns, proteins.[4]

A way to investigate self replication would be to challenge the second criterion; the ability to give rise to a mutated form which is stable. This we can do by introducing some alien self-duplicating patterns into a cell and observing the outcome. Viruses open a means for such observation and may lead to the answer of the ultimate unit of self replication.[6]

Although the virus shows the property of reduplication it cannot accomplish it outside living cells. Its nutritional requirements can only be supplied by the intact living cell. The virus is in itself an inert particle except when present in a living cell. The purified virus does not respire nor possess any of the enzymes known to be associated with energy release. Recent data show the presence of some specific enzymes in certain virus which are probably used in infection of the cell.[5]

This unique ability of duplication dependent on environment provokes a need to define virus. In an effort to formulate a definition we have turned first to the origin of this particle.

A variety of suggestions has been made with respect to its origin. Those which claim current attention are the following:

1) Viruses are descendants of a primitive form of life predating the appearance of organized cells.

2) Due to loss variations through retrograde evolutionary processes resulting from their parasitic existence, viruses retained only the structure necessary for reproduction and genetic function. We see this process in certain bacteria. Due to their highly specialized parasitic existence, they grow only with great difficulty outside the host cell. The largest virus show marked susceptibility to antibiotics which inhibit bacterial growth, whereas the smaller viruses are not susceptible. It would appear that the largest have progressed the least, the smallest having reached the summit of parasitism.

3) The sudden eruption of a fragment of the hereditary apparatus by a cell due to mutation or accident. Within certain cells, if absorbed, these fragments seem to exert an autocatalytic property so that replicas of themselves are formed. They may remain latent for long periods until they come in contact with a susceptible host.[6] It is interesting to note that had the susceptible host never appeared, the virus would never have been activated. Still other suggestions propose that the specificity of virus-host cell relationships can be explained by their descent from a common ancestor or that in the case of the bacterial viruses, they may represent evolution from a primitive mechanism of sexuality, i.e., they are derived from normal cellular components.[7]

These possibilities differ only in the length of time involved. Since a choice is impossible at the present and we cannot determine what a virus is until we know its origin or until experimentation yields criteria to define the terms used, most of the study is left to the consideration of the structure and behavior of virus.[8]

Not only are bacteria capable of parasitizing animals and plants, but they are themselves host to a specific group of viruses called phages. The phage is tadpole-shaped, a characteristic of bacterial virus, composed of a DNA core surrounded by a protein coat of heterogeneous composition. This fact of heterogeneity must not be overlooked, for it accounts for phage types. Lest we should expect the replication of plant and animal viruses to mirror that of the phage, consideration should be given not only to this protein heterogeneity, but also to structure and the fact that core composition differs. In the phage we find DNA, whereas the plant and animal viruses contain a core of Ribose Nucleic Acid (RNA).[5]

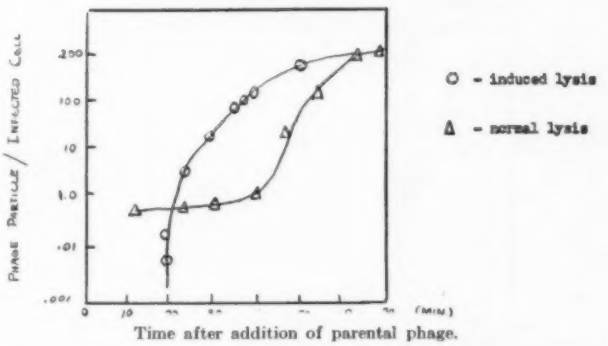
Infection of a bacterium will take place if the cell is sensitive. A phage can attach itself to a bacterium depending on the amount of ionization of the solution surrounding the cell. Puck claims this amount to be phage specific. The phage is attached to the bacterium cell by the electrostatic attraction of its charged amino groups to the carboxyl groups on the bacterium. An additional reaction involves enzymes which apparently act as a glue or possibly open the cell wall permitting the passage of the nucleic acid core into the cell body.[9]

Jawetz, et. al., explain the surface of the bacteria cell to be a structural mosaic of protein particles held together by a mesh of carbohydrate molecules. They propose that the specificity of phage adsorption resides in the cell wall. This specificity appears to be found in discrete localized receptor sites and suggests that adsorption consists of neutralizing the negatively charged carboxyl groups in these sites with the cations on the phage surface. Such neutralization may then activate a lytic enzyme in the host cell which destroys a portion of the wall and permits entry into the cell.[6]

This adsorption and penetration by a phage particle is known as the infective stage of the phage. There follows, upon entry of the nucleic acid core, a period of eclipse in which the actions of the virus defy detection by every direct method of bio-assay. At this stage the virus is non-infectious and to all appearances has disappeared. Tracer studies done on the cell host tell us something of the phage indirectly. The activity of the cell does not increase, but changes; the synthesis of cell DNA ceases and the production of viral DNA begins. In the phages T_2, T_4, and T_6 it is interesting to note the production of a new "building block" for the virus. The viral necessity of a pyrimidine, hydroxymethylcytosine, which has never been found in the DNA of the host is produced by the cell after infection.[6] In addition, the phage is apparently responsible for specific changes in the chromosomal bodies which break and fill the cell with granular chromatin. Could these granules be the phage nucleoprotein? Micrographic counts show such a reaction to occur only if the phage is active.[10]

In bacteria, after a latent period of approximately 25 minutes, the infected cell lyses and releases more than one hundred phage progeny. Such viral release defines the infection of the cell as lytic. Occasionally the infected cell does not lyse but after a period begins normal mitotic division. Such infections, lysogenetic, permit several generations of cells before one lyses and yields infective phage particles. Experiments have shown that lysogenetic bacteria carry no infective particles.[11] The virus is said to have become provirus, a term coined by Lwoff and Guttman. Provirus is a condition of the bacterium which confers upon it a potentiality.[12] Provirus can be visualized as a unit incorporated into the genetic material of the host which remains there for several generations and then resumes its existence as a virus. Population genetics of the bacterium and virus limits the actualization of provirus since reproduction is asexual. Simple fission gives rise to only random mutation. The only variant is environment. Thus we conclude that a lysogenetic cell becomes lytic, actualizing this potentiality because it now possesses a suitable environment.[13]

Latency can be effected in several ways. Specific immunity may come into play before enough virus has been produced



Time after addition of parental phage.

Figure 1. Intracellular bacteriophage population during latent period.

and spread about to cause overt results. If a host is already carrying one virus, the phenomenon of interference between viruses may lead to a suppression of the activity of a second virus.[14]

The mechanics of lytic infection have been demonstrated by several experiments. Doermann found the first virus particles formed after an interval of 13 minutes or approximately half the latent period. If a cell was lysed before this, no infective particles are found. From such data, it is assumed that the virus acquires a vegetative or non-infectious state. The graph in Figure 1 summarizes the data from these experiments.[15]

With the discovery of this eclipse period which yields phage progeny, came the inquiry into phage fabrication. If the bacterium is infected with two types of phage, the host yields phage of both parental types and some which are recombinations. These recombinations offer an opening into the question of phage fabrication. The presence of recombinants

Table 1. Occurence of recombinants in cross $T_2Hh \times T_2Hr$ during latent period.

Expt. No.	Lyse Time	Phage/cell	No. of recombinants	% of recombinants
1	20 min.	2.3	10	2.0
2	20 min.	6.0	97	2.2
1	25 min.	36	8	1.6
3	27 min.	67	81	2.4
2	29 min.	101	34	2.3
1	30 min.	113	19	3.0
1	Post-burst	788	47	3.0
2	"	516	131	3.5
3	"	365	27	2.3

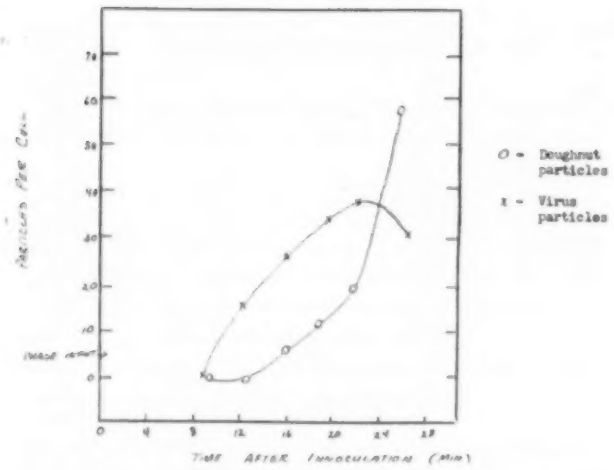


Figure 2. Intracellular growth curve of doughnut and phage-like structures.

necessitates a precursor. Is it a template, a master sheet, of which they are carbon copies? If so, recombination would have to take place before multiplication and produce identical progeny. Such is not the case. Recombinant viruses are produced at random as if each particle of the virus arose independently of the others.[16]

An alternate hypothesis proposes an irreversible template attachment at some specific time during the eclipse period. Experiments done with marker crosses using phage of known rates of recombination would show the earliest progeny to resemble only parental types and the recombinants to follow at a later period. Table 1 presents the evidence from such experimentation.[15]

It is apparent from this and other work that genetic recombination occurs between the time of infection and the time the first phage appears.

The question of protein coat production for the progeny was investigated by Leventhal and Fischer. By lysing infected cells just before the first phage particle could appear, they found structures with the morphology similar to the heads of infective phage. Anderson, Rappaport and Muscatine, studying the osmotic properties of phage particles, showed these to be empty membranes identical to the "empty heads" of shocked phage. A growth curve for these empty membranes, doughnut structures, is given in Figure 2.[16]

Because of their morphological similarity to the empty phage heads, the kinetics of their growth, and additional evidence gained from their chemical composition and antigenic properties, it is concluded that these structures are precursors of phage protein. They should not be mistaken for provirus or the vegetative stage since we see, from the graph, they do not appear until late in the eclipse period.[16]

The Tobacco Mosaic Virus (*TMV*) offers an example of plant virus studied in great detail. The marked difference in the TMV and coliphage is in the nucleic acid core. Phage contains DNA, whereas plant and animal virus contain RNA. General composition characteristics are the same. A large fraction of the virus is protein, approximately 95%, the remaining smaller fraction is the nucleic acid core.

Several proposed patterns of replication have been postulated. The two that apparently hold current favor will be outlined. Commoner and colleagues have pointed out that a solution to viral replication must agree with the facts of viral biosynthesis. In the TMV both protein and RNA content are synthesized *de novo* in the infected cell from low molecular weight precursors. The curve for the doughnut structures rises and then levels off after approximately 21 minutes probably because they are being used to form the intact active virus. Isotope experiments describing the rate of the specific activity of the components at various times after infection and the biosynthetic origin of the protein and RNA residues found in different parts of the virus rod place many qualifications on the replication process. A summary of their work, with related figures and tables, is given.

TMV was innoculated into the leaves of nearly mature *N. tabacum* plants. After a given interval of time, the leaves were exposed to labeled $C^{14}O_2$ for measured periods of time (3 to 45 min.) The virus RNA was separated from the total virus by known methods. Since the protein composes 95% of the total virus, the specific activity of the whole virus was taken as representative of the specific activity of the protein. The specific activity of the RNA was found separately.

The graph in Figure 3a shows the virus content of the infected leaf at various time intervals after infection. From the curve it is possible to estimate the increase in virus content (ΔV) which occurs in a given period of isotope incorporation. The time intervals (Δt) are very short (3 to 45

Table 2. Specific activities of free amino acids isolated from TMV infected tobacco leaf.

		Preparation I		Preparation II	
Free amino acid	% TMV protein	A	B	A	B
Aspartic	13.8	331	46	305	42
Glutamic	11.0	942	104	61	7
Serine	6.9	2,332	161	2,181	151
Glycine	2.1	184	4	329	7
Threonine	9.7	254	25	206	20
Alanine	4.8	137	7	62	3
Total	48.3		347		230
Total TMV	100		722		478

A = Specific Activity (counts per minutes $\times$ 10^3 mg of C^{14}
B = Specific Activity Times Percentage of TMV in Protein
Preparation I was isolated from infected tissue at 126 hrs. after innoculation.
Preparation II was isolated after 146 hrs.

min.) relative to the overall time-course of virus synthesis (several hundred hours.) The amount of virus synthesized during t is a small part of the virus present (less than .1%) so V cannot be measured directly. However the rate of virus formation can be estimated from the slope for any given time. For very small Δt, this rate is, in effect, constant so ΔV can be estimated from the relationship

$$\Delta V = K_v \Delta T$$

The amount of RNA synthesized during a given interval can likewise be determined from

$$\Delta V = K_r \Delta t$$

The specific activities of the total virus, S_v and of the RNA, S_r can be obtained from the same experimental data and calculated from the figure using the relationship

$$\frac{S_v V}{\Delta V} = K_v t \quad \text{and} \quad \frac{S_r V}{\Delta V} = K_r t$$

where K_r and K_v are simply proportionality constants.

Since the formed virus is metabolically inert only the virus synthesized during the period of isotope incorporation contains C^{14}. Thus the specific activities of the newly formed virus and nucleic acid in a specific time interval is given by

$$S_{\text{delta } v} = \frac{S_v V}{\Delta V} \quad \text{and} \quad S_{\text{delta } r} = \frac{S_r V}{\Delta V}$$

The graph in Figure 3b shows the experimental data tabulated. The results indicate the rate of specific activity of the newly formed protein and RNA increase linearly with time.

The source material in the cell relevant to virus protein synthesis is that misture of free amino acids identical in composition to the TMV protein. In reality only 48% of the protein, which yields 6 free amino acids could be isolated. The specific activity of the total pool of available material could be estimated from the activities of two isolated batches of protein. These data, from pertinent experiments, are given in Table 2. The average activity for the two cases cited for the protein is 600 ± 120 cpm × 10^{-3}/mg C^{14}. The corresponding results for RNA are given in Table 3, page 14. In this case only 2 of the 4 free nucleotides could be isolated. The other two are values estimated from their ratios in the RNA nucleotides. The values for k_v and k_r (rate of increase in specific activity of the pool with respect to protein and RNA content) are estimated from the tables as 20,000 ± 4,000 and 6,000 ± 2,000 cpm/mg C^{14}/min. respectively. These observations suggest that the rates of synthesis of the TMV protein and nucleic acid are in the ratio of their respective contributions to the virus mass and are synchronized with the process of formation of the virus.

Investigation done on C^{14} distribution in both protein and acid showed a heterogeneous distribution of the isotope which was apparently a function of the time interval. When the time exposure to C^{14} was very short, most of the isotope was found in the terminal sections. As the time increased the distribution became more uniform. Since we have already shown the specific activity of the constituents to increase with time (Figure 3b) the simplest explanation of this heterogeneity is that the terminal sections are synthesized later than basal sections. This suggests linear growth and when added to the results on the kinetics of protein and acid synthesis, shows that the virus formation involves synchronous extension of both protein and RNA in the direction of the long axis.[17] See Figure 4.

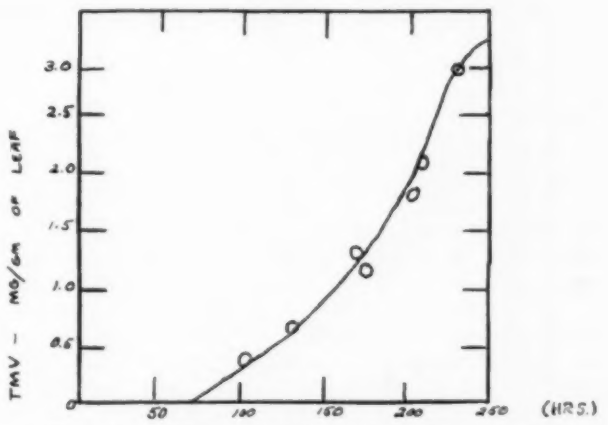


Figure 3a. TMV content of tobacco leaf tissue at various time intervals after innoculation.

If a comparison is made of the isotope levels in the amino acids and ribonucleotides found free in the infected leaf, with those found in the newly formed virus, we can assume these residues to be the precursors or related to the precursors of the virus particles. Biological data indicate that the polymerization of amino acid residues yielding protein depends on RNA. This suggests that the particular amino acid sequence in TMV is governed by the structure and sequence of a particular RNA. Nothing to the contrary indicates that this is not the virus RNA.

Thus in the synthesis of virus RNA and protein, the specificity of the protein synthesis depends on the character of the RNA; yet we find that the biochemical competence of the RNA depends on the protein.

Evidence gathered from the virus shows each rod to contain a single fiber of nucleic acid. A single fiber of a polynucleotide is not capable of maintaining a specific secondary structure. Once released by the constraining protein, the RNA fiber collapses into a random coil in which hydrogen bonds serve to join various segments together. Such coiled fibers are biologically inactive.

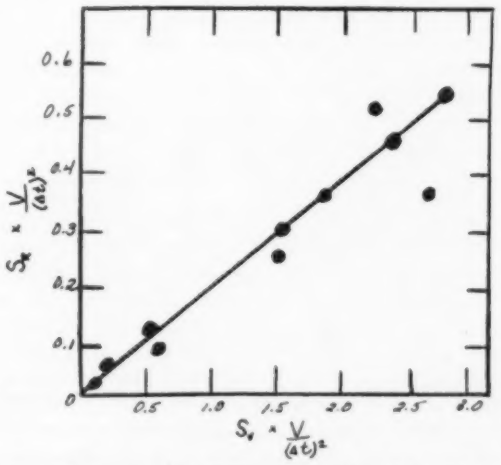


Figure 3b. Relative rates of TMV protein and nucleic acid synthesis determined from their specific activities.

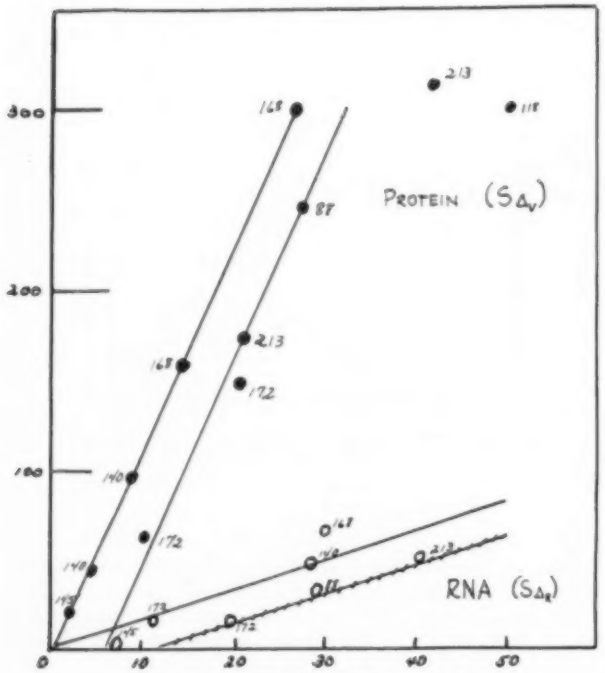


Figure 4. Relationship between TMV protein and RNA vs. time of $C^{14}O_2$ incorporation.

The closed circles represent the protein values, the open circles, the RNA values. Numbers near individual points indicate the number of hours after innoculation that the leaf was exposed to $C^{14}O_2$. Lower solid line and broken line indicate the maximum intercepts on Δt axis that is permissible.

If the virus RNA is to regulate the specific sequence of amino acid in the virus protein, it must: 1) be accessible to the approach of amino acid residues, and 2) retain a specific secondary structure in that a given region of fiber will present a special chemical configuration to the approaching acid residues.

RNA in the rod fulfills this second requirement, but is not accessible because of the constraining protein coat. Freed, it would be accessible but being a single strand collapses and cannot yield the configurational specificity required. An explanation of the germinal competence of the virus RNA can be associated with a segment of the fiber which is attached to an underlying array of protein sub-units. In this condition it is both accessible and specifically structured. Thus the competence of the TMV seems to depend mutually on the protein and RNA. Evidence that has shown RNA to be the infectious agent and protein non-infectious, is not a contradiction since there has been no evidence that it is RNA alone which is infectious.[18]

The mode of infection if TMV is still unknown, but the bulk of replication, conforming with the above theory, is given by a scheme of synthesis from low molecular weight precursors. Consideration given to some general attributes of protein and RNA biosynthesis adds further particulars to those that govern TMV replication with regard to spatial and temporal relationships. Figure 5a, b, c, d, and the following explanation apparently solves these considerations.

5a—The germinal agent is a single turn of the RNA fiber attached to a layer of protein sub-units. This structure shows a single turn of the acid fiber helix, which consists of 48 nucleotides attached to 16⅓ protein sub units composing one turn. Thus we see the acid configuration determined by its attachment to the surfact of the protein sub-units.

5b—The second phase illustrates the appropriate amino acid residues becoming attached to the exposed segment of the acid fiber in a sequence dependent on the nucleotide sequence in the RNA fiber. The amount of amino acid that a single turn of the fiber will accommodate is equivalent to the size of the polypeptide found in a single protein sub-unit. Therefore it is proposed that a single turn of acid fiber provides the locus for the initial polymerization of the amino acids found in a single protein sub-unit.

5c—The newly formed polypeptide chain becomes detached and after suitable foldings assumes the configuration of a protein sub-unit. This affords a step dislocation in the crystal-like array of protein sub-units and allows for the addition to the helix. The newly formed sub-unit becomes the terminal unit in the rod, but is unlike the others because it lacks attachment to RNA nucleotides. Moreover, it covers three nucleotides proximate to the last terminal segment.

5d—It is proposed next, that the RNA segment is extended by terminal acquisition of three new nucleotides, which then become bound to the free surface of the last formed protein sub-unit. This results in the same structural configuration needed to begin the process again.[18]

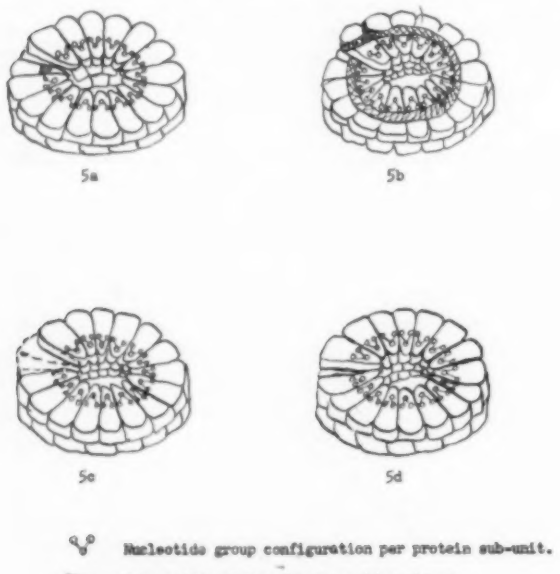


Figure 5. Proposed method of extension in the TMV.

A second hypothesis is suggested by Fraenkl-Conrat. Chemical analysis shows the TMV to be composed of protein and RNA. X-ray diffraction and chemical studies show the center of the rod to be hollow. This, he assumes, allows for an acid rod, not solid but spiraled. Chemical treatment permits the separation of the protein and RNA. The protein is soluble in water and tends toward large aggregations of

(*Continued on Page 114*)

The First Three Hundred Years of the Royal Society

• **By Sister M. Stephanie Sloyan, Ph.D.** *(The Catholic University of America)*
GEORGIAN COURT COLLEGE, LAKEWOOD, NEW JERSEY

The Royal Society was founded in the age of Boyle, Hooke, Wren, and Newton.

Since its establishment, it has always been a leader in the promotion of science.

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Last winter the *New York Times* carried a small note on its education page announcing that the three hundredth anniversary of the founding of the Royal Society of London would be celebrated this year. Since the formation of the Society was an event of such tremendous importance, having such far-reaching influence, it might be appropriate in the year of the anniversary to outline briefly the happenings that led to the Society's establishment, and to chronicle some of its early history.

Beginning in the year 1645 a group of young men met weekly in London over luncheon to discuss things scientific. They were business men, linguists, physicians, scholars (all University trained except for Robert Boyle), or nobles, but, to a man, scientific amateurs. Their interests ranged over what we currently think of as science, but they investigated also methods of manufacture, matters of commerce, and what would now be called technology. Their meetings were a leisure time activity, not part of a full time profession. They were held at some member's lodging, or in a convenient place in Cheapside, or in Gresham College.[1] For a short time the meetings were held at Oxford. (There are varying opinions on whether the Oxford meetings were a new beginning, or the London meetings transferred.) These were troubled times, times of Civil War, and the group agreed that the discussion of politics and "news" was forbidden. For a period of years the meetings went on, sometimes regularly, sometimes intermittently.

"In London, in 1659 the meetings were held twice a week at Gresham College, where Mr. Robert Boyle lectured in chemistry, Mr. Christopher Wren on astronomy, Mr. Lawrence Rooke on geometry, and others in related fields."[2] On November 28, 1660 the "invisible college" as the group was called by Robert Boyle in a letter, agreed to constitute themselves into a society.[3] At first it was decided to limit the membership to fifty-five, but the list grew. Among the first members were Sir Robert Moray, Robert Boyle, Robert Hooke, Thomas Sprat, John Wallace, Christopher Wren, and John Winthrop, Jr. A president, secretary, and registrar were elected from this body. King Charles II granted a royal charter on July 15, 1662, and the group incorporated under the name of the *Royal Society of London*. (The name was suggested by John Evelyn.) The first meeting of the Society as such was held appropriately at Gresham College with Lord Viscount Brouncker as president. There were 119 charter members.

The object of the Society was to advance experimental knowledge, and to interpret nature by seeking to encourage direct contact with nature. Actual experiments were performed at the meetings. In fact there was a regulation that if a man failed to bring in his experiment appointed for the day, or failed to provide a substitute, he should be fined two shillings six pence "and shall perform his task notwithstanding". In addition the members were interested in collecting information on the natural history of foreign countries and carried on an extensive correspondence with member of similar societies in France and Italy.

Charles II was not of too much assistance. He lent his name and his sanction to the infant Society, but no money whatever. Someone has said that granting the charter to the Society was one of the few wise things Charles did. Only a few months after awarding the charter he could scoff at Gresham College for spending time in the weighing of "ayre". The Society had supporters in its early days, but sharp critics as well, and as early as 1667 Thomas Sprat wrote a history of the Society in order to defend it. Otherwise, why would one need a full length history of a society only five years old? This history has recently been reissued as one of the Washington University Studies.[4] Sprat himself says that his work is partly an apology:

> The style perhaps in which it is written, is larger and more contentious than becomes that purity and shortness which are the chief beauties of Historical Writings; But the blame of this ought not so much to be laid on me, as upon the Detractors of so noble an Institution; For their Objections and Cavils against it, did make it necessary for me to write of it, not altogether in the way of a *plain History* but sometimes of an apology.[5]

Robert Hooke, first curator of the Society had much to do with drawing up the statutes. As curator he had apartments in Gresham College, but in the beginning the Society had no laboratory (then called an elaboratory). Boyle frequently lent his personal apparatus for demonstrations, and instruments were sometimes presented by their inventors to the Society, e.g., Newton's telescope and Huygens' lens. Sprat chronicles a list of apparatus owned by the group. The objects range from pendulum clocks through magnetic instruments to an instrument for planting corn.

Beginning in March, 1664, the *Philosophical Transactions* appeared, composed by Henry Oldenburg, second secretary of the Society. This journal was published monthly and contained the matters of most importance communicated to Oldenburg by the members of the society or by foreign scientists. Boyle contributed extensively to the *Transactions* and Leeuwenhoek wrote three hundred and seventy-five pages over a period of fifty years. The *Transactions* is the oldest scientific journal in the English language which is still published, and it missed by three months being the oldest scientific journal of all.

Over the years the roster of members sounds like a scientific honor roll. Sir Isaac Newton became a member of the Society in 1671, and Halley in 1678. Halley it was who studied earth magnetism and constructed the isogonal lines of magnetic declination, besides calculating the orbit of "Halley's" comet and predicting its return. Newton communicated to the Society his theory of light and colors, but this theory was attacked by Hooke and Huygens. The Royal Society materially aided Newton in the publication of his works. In fact, the Society intended to publish the *Principia*, but when there was some heated discussion with Hooke about priority of discovery, Halley, a friend of Newton, published it at his own expense.[6] Newton served as president of the Society from 1703 until his death in 1725 and did much to make its place in English life secure.

Mention of the Society even occurs in literature, since during the 17th century there appeared a number of plays, poems, and prose works satirizing false science, and satirizing, attacking or eulogizing true science.[7] In 1676 Thomas Shadwell wrote a play entitled "The Virtuoso", ridiculing the Royal Society and its labors. This play contained a character named Sir Nicholas Gimcrack, a caricature of Sir Robert Howard, Fellow of the Society. Samuel Butler had some sharp things to say. On the other hand, John Dryden (elected Fellow November 26, 1662) listed the benefits conferred or likely to be conferred on humanity by scientific research:

> Among the asserters of free reason's claim,
> Our nation's not the least in worth or fame.
> The world to Bacon does not only owe
> Its present knowledge, but its future too.
> Gilbert shall live, till loadstones cease to draw,
> Or British fleets the boundless ocean awe,
> And noble Boyle, not less in nature seen,
> Than his great brother, read in states and men.
> The circling streams, once thought but pool, of blood
> (Whether life's fuel, or the body's food)
> From dark oblivion Harvey's name shall save;
> While Ent keeps all the honour that he gave.[8]

Since earliest times there have been American members of the Society, and there have been at least two articles describing their election and contributions.[9, 10] In Brasch's article he speaks of the work of John Winthrop, Jr., oldest son of the first governor of Massachusetts and the first colonist elected fellow in 1662 when he was living temporarily in London. Winthrop was a physician and a chemist and became western correspondent for the Society. Now it is an honor to be a correspondent, but then it was a duty and he really had to correspond—with some of the most famous men of the 17th century. Benjamin Franklin, elected in 1756, carried on a voluminous correspondence, most of which is preserved in the Library of Congress. The Society has a policy of electing fifty "foreign" members as opposed to "home" members who are British but work in another country. James Bowdoin was the first American foreign member elected after the American Revolution. For a long period (1818–1852) no new American member was elected, but in the period since 1918 the number of American members has increased. J. Willard Gibbs was elected in 1897, A. A. Michelson in 1902, Harvey Cushing in 1933, and Irving Langmuir in 1935, to name a few.

So much more could be written about the Society. William Bragg, in his presidential address of 1939, gave an excellent overview of the changes in the type of work presented to the Society over the three hundred years.[11] He spoke of the interest of the Society in the establishment of the Greenwich Observatory; of the work of Samuel Pepys, one-time president, in whatever would advance the cause of the Navy; of the many, many papers written on the ventilation of coal mines. In the early days any educated man could read with profit all the articles in the *Transactions*, but as time went on and the topics became more specialized in the time of Young, Fresnel, Davy, and Faraday, only scientists could understand.

Perhaps the most complete, and yet most highly readable account of the Society's history, ancient and modern, is that of Dorothy Stimson.[12] She tells of the group's foundation, its fat years and lean, the times when it almost passed out of existence, and the times when it was the greatest single influence on British science. She speaks of its various homes (all too small)—Gresham College, Crane Court, and Burlington House, its present site. Sir Henry Dale, president in 1943, wrote then about the difficulties the Society has always faced in acquiring and maintaining a permanent home.[13]

Throughout the years the Society has continued to publish the *Proceedings* which originated in 1832 as "Abstracts of the Papers Published in the *Philosophical Transactions* of the Royal Society of London", as well as the *Transactions*.[14] Both are now published monthly, in two series, A and B, representing physical and biological science, and the *Proceedings* no longer contain abstracts but complete scientific articles.

Very much more should be written about the later activities of the Society: its awarding annually and biennially so many medals so highly prized by the recipients; the decision to admit women (arrived at with great difficulty!); the fellowships supported by it; and the numerous expeditions sponsored by it. But there is no space in so shart a summary to include all these things. No doubt the present President in his yearly address in November will have important and definitive things to say about the Society at the present time. He may be proud of what his Society has done in three hundred years to advance the sum of human knowledge, confident that it has continued to carry out its original declared business and design—

> To improve the knowledge of all naturall things, and all useful Arts, Manufactures, Mechanick practices, Engynes and Inventions by Experiments—(not meddling with Divinity, Metaphysics, Moralls, Politicks, Grammar, Rhetorick, or Logick).[15]

NOTES

[1] Martha Ornstein, *The Role of Scientific Societies in the Seventeenth Century*, (Chicago: University Press, 1928), p. 93.
[2] Frederick E. Brasch, "The Royal Society of London and its Influence upon Scientific Thought in the American Colonies", *The Scientific Monthly*, (October, 1931), p. 337.
[3] Ornstein, p. 101.
[4] Thomas Sprat, *History of the Royal Society*, (edited by Jackson I. Cope and H. W. Jones), (St. Louis: Washington University, 1958—first printed in 1667).
[5] *Ibid.*, Advertisement to the reader.
[6] Ornstein, p. 138.
[7] Norman Davy, *British Scientific Literature of the 17th Century*, (New York: Barnes and Noble, 1953), p. 217.
[8] *Ibid.*, p. 222.
[9] Brasch, p. 338.
[10] Heindel, "Americans in the Royal Society 1783–1937", *Science*, n.s. 87, (March 25, 1938), 268.
[11] W. Bragg, "History in the Archives of the Royal Society", *Science*, n.s. 89, (May 19, 1939), 445–453.
[12] Dorothy Stimson, *Scientists and Amateurs*, (New York: Henry Schuman, 1948).
[13] Sir Henry Dale, "The Royal Society and its Homes", *Nature*, 152, (December 4, 1943), 649.
[14] Preface to *Index of the Proceedings of the Royal Society of London*, Vol. 1–75, (London: Harris and Sons, 1913).
[15] Ornstein, p. 108 n. (taken from Hooke's papers written in 1663).

Odenbach Seismic Laboratory I

• **By a group of students McQuaid Jesuit High School**
ROCHESTER, NEW YORK

The principal authors of this report are Chris Husson and Daniel Doell. The following are co-authors: Douglas Bufano, Paul Weiss and Paul McAvinney.

This interesting extracurricula activity owes its start to the guidance of its 1959–60 moderator, Mr. R. Drake, SJ.

Mr. Angelo Lamendola, technical director of the laboratory, will give a further description of the laboratory in our March issue.

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On Saturday, January 3, 1959, a spadeful of dirt was turned in a damp and dark end of an unfinished storeroom in the basement of McQuaid Jesuit High School. This spadeful represented the beginning of another Jesuit seismograph. After several months of planning, actual work had been started in the digging of a five foot square hole to accommodate the concrete pier on which the sensing instruments, the seismometers, of the Odenbach Seismic Observatory now rest.

During the first few days of work everything went fine, but when we reached a depth of six and one half feet, water began to seep into the excavation. By Monday, January 12, we were forced to abandon a pneumatic compressor and hammer, and press into service pails and pumps, since water was flowing into our excavation at the rate of one hundred and fifty gallons per day. Because of the mid-term examinations, there was a two week suspension of work.

After the examinations, we started again on our quest for bed-rock, estimated to be about twenty feet below the surface. At a depth of twelve feet, we were halted by two large boulders of dolomite, a type of very hard rock. Further inspection showed that these boulders weighed approximately seventy-five tons. Removing these rocks so that we could continue digging to bed-rock for a firm foundation for our pier would be a very time-consuming process. A call to Father Joseph Lynch, S.J., Director of the Fordham University Seismograph, our parent organization, settled the whole problem. He suggested that we "make our own bed-rock" by connecting the two boulders with concrete.

The week of January 25, 1959, was spent in making forms for the pouring of the concrete. On Saturday, January 31, several McQuaid students poured eleven tons of concrete into forms for the pier. In a week the forms were removed and the concrete was cured. We then set up the seismograph instruments and made countless adjustments to get the seismograph into operation. Finally, on Friday, February 13, 1959, the Odenbach Seismic Observatory went into service as a link in the monitoring system of the U. S. Coast and Geodetic Survey.

Since then the seismograph has been kept in almost constant operation, even through the summer, through the unselfish efforts of several McQuaid students.

Since the only truly permanent structure in our unfinished seismic vault was the pier, when we came back to school in September, we decided that our valuable equipment ought to have a more permanent location that would include a darkroom, recording room, exhibit room, and store room. We set out to put in a floor, walls, and a ceiling.

The project commenced on Monday, October 5, 1959, when the very delicate recording instruments of the seismograph were moved to a temporary location fifty feet away from the pier to be out of the way of the construction work. On Thursday we began to raise and level the dirt floor, prior to laying the concrete floor. To help with the raising and leveling operation several loads of fill dirt were used. On three successive Saturdays, October 17, 24, and 31, twenty-two yards of concrete were poured for the fifteen hundred square feet of floor. For our walls six hundred pounds of mortar and one thousand cement blocks were delivered on October 31. Several more hundred pound bags of mortar and five hundred more blocks were delivered later.

On November 3, three tons of sand were delivered for mixing mortar. We were now ready to begin the second phase, the erection of the cement block walls.

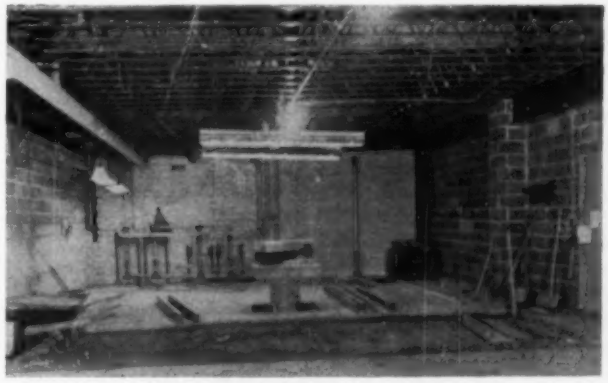
A few weeks later the first blocks were laid for the darkroom and recording room walls. By the middle of December these walls were completed. Then we went to work on the storeroom walls, which were finished in about a month.

Electricians came one Saturday in the latter part of January and installed all the wiring and the lights for us.

After the wiring was in we started the third phase, putting in the ceiling. All through the month of February we worked to clean and install the ceiling tiles salvaged from the old cafeteria, which was gutted by fire in 1955. We were beginning to see the end now.

In March the plumbing for the sinks was installed in the darkroom, where one day we would develop the photographic paper from the seismograph.

(*Continued on Page 126*)



Observatory under construction

Honey: An Ancient Yet Modern Medicine

• **By John Stomfay-Stitz, Ph.D.,** *(University of Budapest)*
PROFESSOR OF BIOLOGY, DUQUESNE UNIVERSITY, PITTSBURGH, PENNSYLVANIA

"Of honey, wind-bred bounty of the sky,
Next let me sing . . ."

VIRGIL, The Georgics, Book IV.1.

●

The use of honey for food as well as for medicine parallels the rise of humanity. I have come to the conclusion that the applied sciences are becoming more and more differentiated and that there is a honey-science. This science I have named Melilogy and have further defined it in my book "Honey".[1] By this branch of science, I mean the end results of research in the various auxiliary sciences which relate to honey such as physical and soil chemistry, biology, biochemistry, botany, microbiology, zoology, climatology, history, geopolitics, statistics, etc.

It is assumed that the founder of Melilogy was the Greek philosopher and scientist Theophrastus (372–287 B.C.), disciple of Aristotle, who wrote a monograph on honey and other botanical treatises. His work is lost, but fortunately it has become known to us through references in early scientific writings.

Our search for the use of honey as a medicine begins with the ancient Egyptian medical papyri. Six important papyri have served as sources. They are: (1) *The Kahun Medical Papyrus*, the most ancient (about 1900 B.C.) contains only three pages in very poor condition. This papyrus in hieroglyphics discusses women's diseases and the use of honey as an ingredient in some prescriptions, (2) The *Edwin Smith Papyrus* (about 1600 B.C.) concerns wounds and fractures and contains prescriptions for many different diseases where honey is used as an ingredient, (3) The *Papyrus Ebers* (about 1550 B.C.) contains prescriptions for various physical diseases and ailments. The first translation was written and published by George Ebers in 1873, and it has been the most important source of knowledge of medicine as it was practiced in the ancient world, (4) The *Hearst Papyrus* (circa 1550 B.C.) contains many of the same prescriptions that are found in the Papyrus Ebers, (5) The *London Medical Papyrus* (about 1350 B.C.) is in very poor condition and contains little of value except for a few prescriptions, and (6) The *Berlin Medical Papyrus* (about 1250 B.C.) contains a few different prescriptions without a system and of little medical value. (The last three papyri were published by W. Wreszinski.)

The ancient Egyptian priests were for the most part excellent physicians. They were acquainted with the symptoms and treatment of many different diseases and were also skilled surgeons. These "Sachmet-priests" used both psychology and psychiatry in their magic arts. Incantations much like those which the hypnotists employ were used as psychological devices by these priest-physicians. In discussing the contributions of Egyptian physicians, B. Ebbel[2] concluded in his work "The Papyrus Ebers":

> The ancient Egyptian physicians were not, of course, free from superstition. They were creatures of their age and it is not to be expected that they would be at the same level as we are. But Papyrus Ebers clearly shows that they must have been good observers and scientifically-reflecting investigators who were capable of developing the medical art to a high level several thousand years ago and who deserve our profoundest respect. They were certainly not merely "magicians" contending with a demon-infested world.[2]

The *Papyrus Ebers* has also proved to be the most valuable source of information concerning the use of honey as medicine. This papyrus was found by George Ebers in an Egyptian tomb. He published the translation and facsimiles in 1875. This priceless papyrus was saved from destruction during World War II by being removed from the University Library of Leipzig and hidden for safekeeping. This papyrus, 20 meters long and 30 centimeters wide, is written in the hieratic, or cursive form of hieroglyphics, conventionally inscribed from right to left with a blunt reed pen. The Papyrus Ebers written about 1550 B.C. is not an original work but a copy. In the text are found references to remedies used in the first dynasty (more than 3000 B.C.). For example, there is a remedy for growing hair for King Tety's mother, Sesh, who lived about 2500 B.C.

The Papyrus Ebers contains nine parts including discussion and prescriptions for the following: internal medical diseases, surgical disorders, diseases of the eye, the skin and extremities, diseases of women and "matters concerning the household", information of an "anatomical, physiological, and pathological nature", and "incantations before medical treatment to increase the virtue of the remedy". A close examination of this work shows that the prescriptions were used not only as cures for ailments, but to correct symptoms as well. Ebbel, cited above, concluded:

> Of medicines, an imposing quantity is mentioned, taken from the vegetable, animal, and mineral kingdoms. Assuredly, several of these remedies were without any great value, but this does not mean that the whole of the ancient Egyptian MATERIA MEDICA is but a collection of inefficacious and superstitious drugs. A closer study shows that many of the remedies contain chemical substances which are, no doubt, very effective.

Honey is used in the prescriptions and recipes not only as a medicine which has a valuable curative effect, but also as a taste corrective and as a vehicle for other ingredients. The Egyptians used honey with no knowledge of the bacterial effect. They knew nothing of inhibine, vitamins, hormones, proteins, etc., but they did realize that honey had excellent curative properties. For this reason, in 966 prescriptions enumerated in the Papyrus Ebers, honey was used in 319 of them—30.28 percent, which is a significant percentage. Prescriptions which contained honey as an ingredient were written for the treatment of internal diseases such as various stomach and bowel disorders, bladder and urinary ailments, diarrhea, tapeworm, hemorrhoids, appendicitis, etc. There are also prescriptions using honey in remedies for miscellaneous

ailments such as coughs, dropsy, and asthma. From a total of 324 prescriptions to cure internal disorders of various kinds, 179 contain honey.

Special attention is given to prescriptions for eye disorders. There are prescriptions for eye injuries, improvement of the sight, for contraction of the pupil, and for expulsion of white spots (leucoma cornea). There are prescriptions for conjunctivities, catarrhs, cataracts, trachomas, and blindness. From 99 prescriptions for eye disorders, 45 contain honey. There are many prescriptions for the treatment of skin disorders, burns of various degrees, ulcerations, blisters, healing wounds, and stopping bleeding. There are prescriptions for darkening a burn and for treating lash marks from whipping and striking. Honey was specifically a prime ingredient in the treatment of severe burns with ulceration. It was also widely used in bandaging wounds. From 168 prescriptions for skin ailments, 31 used honey as an ingredient. In a salve or ointment, honey was an excellent material.

Honey was used occasionally in prescriptions to heal the extremities. It was used to soften the knee and by Egyptian surgeons in bandaging ankles, fingers, toes, etc. Honey was used frequently in ointments to soften limb joints. From 194 prescriptions, 24 included honey as an ingredient.

In various women's disorders, honey was used to remedy rheumatic pain and hemorrhage, as well as other organic ills. In 71 prescriptions, 11 used honey as an ingredient.

In various surgical disorders, honey was used specifically in prescriptions for cystoid enlarged glands and boils in the throat (angina phlegmonosa).

Honey was employed to remedy such miscellaneous ailments as impetigo, dandruff, gonorrhea, baldness, mumps, etc., as well as to improve skin, beautify the body, and remove wrinkles. Honey, it appears was used by Egyptians in cosmetology as well as in medicine! From 83 miscellaneous prescriptions, 24 included honey as an ingredient.

The *Veda*, sacred scriptures of Hinduism and written in Sanskrit, also contributed to medical research. (The age of the *Veda* is not known, but has been estimated by research scholars to be about 5,000 years old.) The chief specimens of this Vedic literature comprise the *Four Books of Wisdom*, one of which is *Ayurveda* or the *Veda* of *Sacred Formulas*. The Ayurvedic system is still taught in many Ayurvedic Colleges. For four years these students study the doctrines prescribed in the *Veda*. In this ancient literature, the significance of honey as a curative is noted. Dr. C. Dwarkanath, formerly the Principal of the Ayurveda College, Mysore, and presently an adviser in the Ministry of Health, New Delhi, has called my attention to an article by Bhatia, Subrahmanyan, and Srinivasan[3] based on medical remedies discussed in the Ayurveda of ancient India?

> Manifold therapeutic potencies are ascribed to honey in Ayurveda. Honey provokes nervous function (Vata), cures haemorrhagic diathesis (Rakhthapita) and phlegmatic disorders (Kapha), and promotes the synthesis of body humours, and is lysic, dry, astringent, and sweet.[3]

The Greeks recognized the great importance of honey as excellent foodstuff and as a benefit to health. There is little doubt that Greek athletes were always given a mixture of honey and water to drink after the Olympic games because they found this beverage to quickly banish fatigue. It was used as a panacea for diseases and ailments and was recommended by the philosophers to prolong life. Pythagoras (582–500 B.C.) used large amounts of bread and honey in his diet, and his disciples adapted and carried on his diet as well as his Pythagorean Theory. Apollonius, the Greek philosopher, lived to the age of 113, and the Greek lyric poet Anacreon lived to be 115. Hippocrates (460–357 B.C.), the "Father of Medicine", used many of the Egyptian prescriptions and admired honey's therapeutic value. He found that honey was an excellent expectorant: "...it causes heat, cleans sores and ulcers of the lips, heals carbuncles and running sores". Dioscorides, the Greek physician who lived in the first century A.D. was influenced by the Egyptian medical writings when he wrote the work, "Materia Medica".

Rome was also a scientific center. The most important scientists in the first Christian century were the Greek slaves in Rome. The most famous Latin physician was Aurelius Cornelius Celsus who was called the Roman Hippocrates and his best-known work is entitled "De Medicina". It is possible to trace his principles indirectly through the Greek writings to the Egyptian medical writings. Celsus used honey in his prescriptions for many different purposes: as a laxative, an astringent and fever cure, as a cure for diarrhea, upset stomach, coughs, throat maladies, ulceration in the interior of the throat (which the Greeks named peripneumoniacum), agglutinate wounds, and for opening the stomach. For emetic, Celsus used honey in an interesting way: "... for purging with a honeyed-wine, it should be made from boiled honey"[4]. This was a mistake because boiling destroys the inhibine as well as other valuable substances. Celsus also used raw honey for cleansing: "If the tongue is dry and scabrous, honey cleans it". Honey was also used in the "pill of Cassius" for colic as well as for eye disease (trachoma) caused by the specific virus, Chlamydozoön trachomatis. The antivirusal effect of honey is being studied presently by the author.[5]

(*Continued on Page 116*)

HIEROGLYPHIC TRANSLITERATION OF COLUMN XXI OF THE PAPYRUS E. SMITH

EXPLANATION: The seventh symbol in the fourth line proceeding from top to bottom represents honey.
The ninth symbol in the same line represents the bee.
The second symbol in the seventh line is also a representation of honey; while the fourth symbol in the same line represents the bee.

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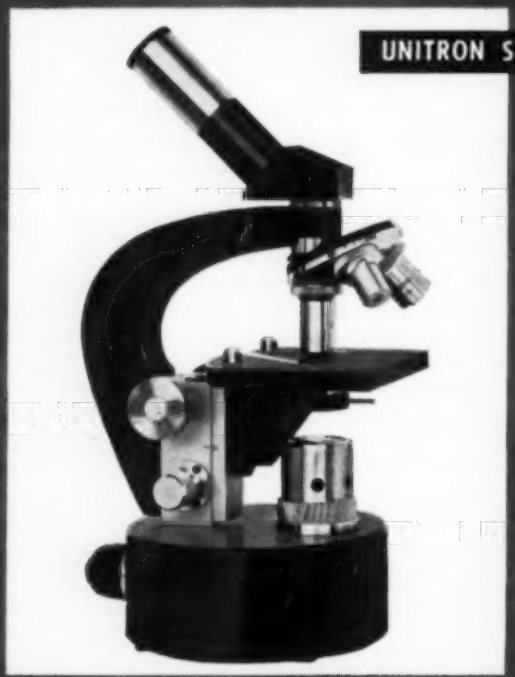

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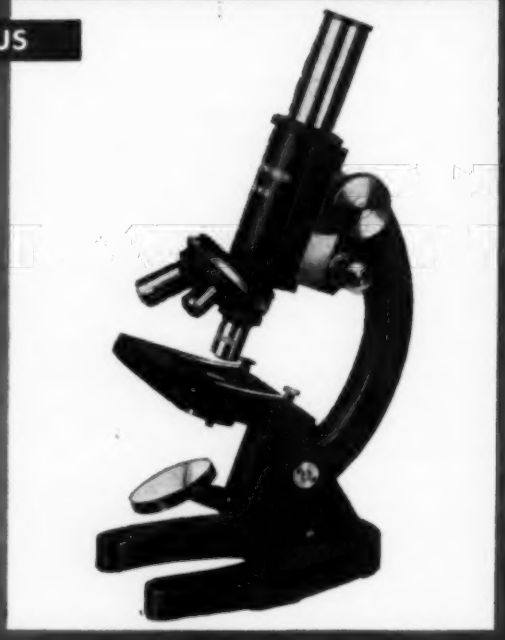

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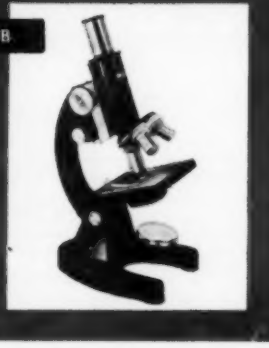

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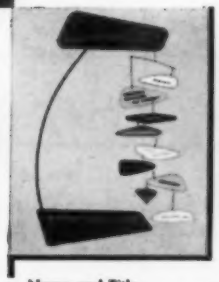

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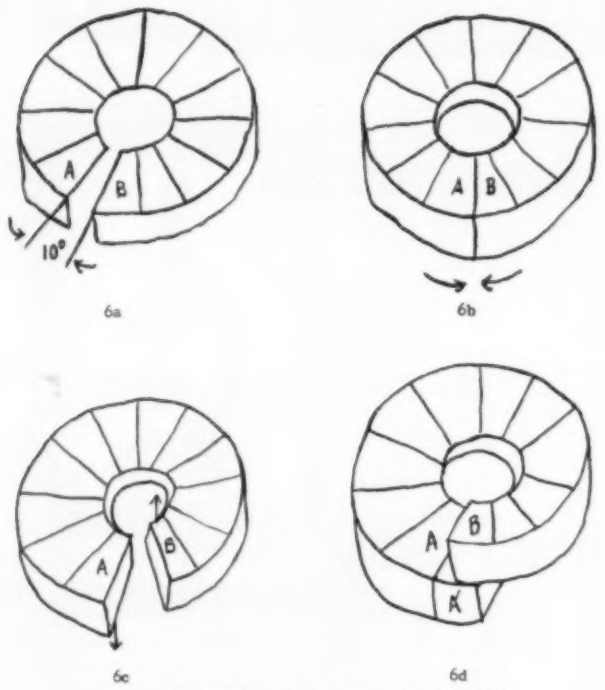

Figure 6. Proposed method of extension in TMV.

The Mechanisms

(*Continued from Page 106*)

molecules. This is an unusual behavior and is explained as due to special sites of "auto-affinity" on the sides of the protein molecule. Such affinity permits the protein molecule to form sectors like a pie and unite in a spiraling manner building the characteristic rod.[19] Sears provided for this growth on the basis of the screw dislocation mechanism of crystalline growth. He assumes that certain experiments, on solution and reprecipation of TMV protein, demonstrate the tubular habit independent of the absence or presence of RNA.[20] Yet, Fraenkl-Conrat, whom he quotes, admits to contamination of the protein solution with approximately 1×10^{-6} parts of active RNA.[19] Is this of significance?

X-ray diffraction also reveals the structure of the protein wall to be of equivalent elements arranged on a helix having a pitch of 23 Å. It has been estimated that there are $3n + 1$ elements in three helical turns, where n 12. The outer cylinder diameter is 150 Å, the inner 51 Å.

In the tubular form, 12⅓ structural elements are arranged in a single turn of the spiral. These 12 elements enclose 350°. Two possible configurations may result. The ring may deform its plane, form a bond, and close or may be elastically deformed into a lock washer. If this second alternative occurs, the addition of new structural elements could occur at either end of the lock washer. With the addition of a new element there is formed an add-on site analogous to the screw dislocation in a crystal. Figure 6a, b, c, and d illustrate the process.

The synchronized growth of the core is a necessary sequence to the tube formation. Screw dislocation does not allow for supersaturation in a solution, since this type of growth is dependent solely on a permanent step. In the heterogeneous mixture of protein and RNA, the protein synthesis could continue indefinitely. With removal of the amino acid residues needed for the protein, the solution becomes supersaturated with respect to the nucleotides. This would permit nucleation of these residues to produce the inner RNA rod.[20]

Nucleotide	Molar ratio in TMV-RNA	Specific Activity – CPM x 10^{-3}/mg C^{14}					
		Preparation I			Preparation II		
		Virus RNA Nucleotides	Free Leaf Nucleotides	Specific Activity of Free Nucleotide x Molar Ratio	Virus RNA Nucleotides	Free Leaf Nucleotides	Specific Activity of Free Nucleotide x Molar Ratio
Cytidylic Acid	18.5	0.065	48	8	0.048	(21)	(4)
Adenylic Acid	29.5	1.006	591	174	0.408	176	52
Guanylic Acid	26.0	0.175	(103)	(27)	0.325	(140)	(36)
Uridylic Acid	26.0	0.248	(146)	(38)	0.075	81	21
Total RNA	100			247			113

Table 3. Specific activities of free ribonucleotides and of ribonucleotides isolated from TMV ribonucleic acid in infected tobacco leaf.

The interaction of virus and animal cells involves some steps similar to those discussed. The penetration of the particle sometimes involves total particle entry. The particle, as a whole, can be recognized within the cell for a short time. Then, in all cases studied without exception, the virus particle disappears. This may be attributed to cellular enzymes. The disintegration of the particle begins the eclipse period. The mode of replication is specific for the particular virus, and may be linear or geometric. In most cases the process of virus maturation is invisible, but leads to the production of virus particles which, when freed from the cell, are visible.

In general, the invisible particles, the building blocks of the virus, exist in pools from which can be drawn mixtures and recombinations. Virus release results in destruction of at least part of the cell, but not necessarily death. There also exists the lysogenetic state in virus infected animal cells, where the actualization of the virus is delayed several cell generations.[21]

Animal viruses resemble plant virus and phage in method of replication and basic constituents, but differ in their mechanism of cell penetration and progeny release. This is probably due to the rigid cell wall found in plants, but not in animals. This necessitates the shedding of the protein coat in plant virus, before penetration into the cell. The ejection of progeny with protein coats demands the breaking of the plant cell wall. The characteristics of the two as far as progeny total number is concerned is similar. Plant and animal virus are released slowly over a long period of time, whereas phage releases the total progeny yield at once.

The striking difference in host range may be due to requisite high specificity interactions between the plant virus and plant cell because of the cell wall. A stronger attachment is needed here to produce distortion. The broader range in animal virus may be only apparent since there is a greater difference physiologically and biochemically between two bacterial cells than there is between two mammal cells.[22]

Experiments have indicated RNA as the possible infective agent in plants. If the enzyme ribonuclease is given up to 2 hours after infection of TMV, the viral action is suppressed. LeClerq showed the same results with the intracellular multiplying influenza virus.[23]

If RNA is the infector, how much is needed to begin the process of replication? Frisch and Nigglemeyer found that 1/1,000–1/10,000 of the amount present in the cytoplasm is sufficient. But there is no evidence that RNA alone is the penetrating particle. Hershey shows that even in T_2 bacteriophage some 3% of the phage protein enters the cell. And evidence has been offered for the fact that some protein is also necessary in TMV replication.[5]

In releasing progeny, the animal cell does not burst. Examination of the cell membrane shows no lesions. Studies of electron micrographs show filamentous processes of varying lengths protruding from the infected cell. These filaments possess terminal nodules or internal beading similar to the spherical form of the virus. These filaments are not infectious and Hoyle suggests this is the process of excretion of the virus material during which the particle matures, i.e., acquires infectious properties.[16]

In conclusion, the only thing that can be said by the writer

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is simply that the mystery of self-replication, even at the apparently simple level of the virus, is far from solved. Much work has been done, but there remains even more, before the answer is defined.

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★ ★ ★

Honey

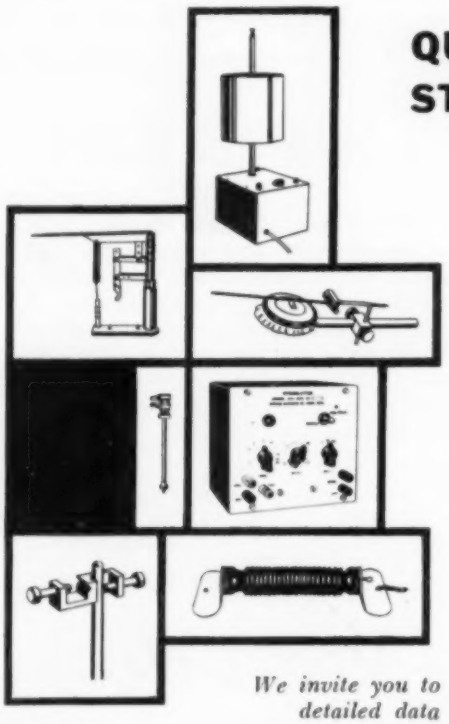
(*Continued from Page 111*)

Pliny, the Elder, who lived in Rome between 23–79 A.D., wrote the great work, "Historia Naturalis", an encyclopedia of nature and art comprising 37 books. Beck concluded:

> Pliny, the Elder, had written more on the nutritional and medicinal value of honey than almost any other ancient author. He, too, believed that the daily use of honey insured long life and good health"[6].

Galen Claudius, the Greek physician, (130–220 A.D.) who was an outstanding physician of antiquity, should be included here in our discussion because he lived most of his long life in Rome. He wrote medical works of the same type as the Greek Dioscorides, and used primarily the prescriptions of Hippocrates. These were called Galenicals.

In the Arabic world, medical science was influenced primarily by the patriarch of Constantinople Nestorius (380–45 A.D.) who accumulated the scientific writings of Egypt,



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Greece, and Rome, and translated the works of Hippocrates, Celsus, and Galen into Arabic. Cumsten wrote in his History of Medicine:

> The Arabs are fatalists: hence, they should appear to neglect the care of the body. But this does not absolutely conform with the truth because Mohammed repeated unceasingly, "God has not inflicted diseases on mankind without at the same time giving us the remedy".[8]

In the centuries following the death in 632 A.D. of the prophet Mohammed, Arabic influence spread throughout the Near East to parts of Europe, particularly Sicily and Spain. The cultural and scientific contribution of the Arabs to Western civilization during the Middle Ages was highly significant in the fields of philosophy, mathematics, medicine, and astronomy. One of the greatest physicians was Avicenna (980–1037 A.D.) who was born in Bokhara, Central Asia. He was a philosopher as well as a physician and was the author of approximately one hundred works on the subject of logic, theology, philosophy, medicine, and mathematics. His principal work is a textbook of medicine, "The Canon", which from the twelth to the seventeenth century was regarded in the Orient as a final authority on medical questions. Avicenna, as well as Rhezes, also an outstanding physician, translated the ancient medical manuscripts into Arabic. Cultural influence spread into Spain and to other parts of Europe and Arabic medical contributions spread also. The two paths of medical science were from Greece and Rome on the one hand and from Moorish Spain to Europe on the other.

The Middle Ages did not give full recognition to the use of honey as a medicine. Medical practices and folk medicine used honey as a medicine only in the sense of the ancient Egyptian prescriptions, but added nothing further to the scientific development of its use, so we will, therefore, consider next the use of honey as a medicine in modern times.

The therapeutic effect of honey is its most fundamental principle. This was formulated excellently by René Chauvin:

> The therapeutic effect of honey was well known at the height of antiquity and it is recognized throughout modern times. But the great difference lies in the application of this fundamental principle.[9]

This is undoubtedly a most sagacious observation, but it is not enough. We must examine the *source* of honey's therapeutic effect. What are the substances that determine the healing effects? In essence, What is honey? Today, in spite of new methods and apparati which aid greatly in the detection of the many unknown substances and properties of honey, many secrets and unknowns still exist.

What is the chemical composition of honey? It is primarily a sugar solution with a water content of 13–22 percent. The two monosaccharides, fructose (35–50 percent), and glucose (32–40 percent) make up the highest percentages in content. Other sugars are known to exist which are primarily sucrose, maltose, melecitose, and dextrines. Moreover, new chemical research has discovered eight di- or trisaccharides and nine oligosaccharides. Research in the chemistry of honey was greatly aided by the development and use of the infrared spectra and paper-and-carbon Celite chromatography. White and Hoban demonstrated with the use of infrared

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spectra the presence in honey of nigerose, isomaltose, turanose, and maltulose.[10] Goldschmidt detected through the use of paper chromatography, isomaltose and erlose in honey.[11] Two Japanese scientists Toshkiyuki and Kiyoshi, detected the presence of kojibiose and leucrose through the use of carbon Celite and paper chromatography.[12]

Honey contains different organic acids: From the volatiles, formic and acetic acids; from the nonvolatiles, malic, tartaric and citric acids. Moreover, oxalic and phosphoric acids and traces of succinic and lactic acids also exist.

There are small amounts of vitamins present in honey. There are traces of all the vitamins in the B group and also Vitamin C. Most important of all is the enzyme content of honey. Invertase, diastase, amylase, catalase, phosphatase were found to be present in honey. The ash content consists of the following elements: Al, B, Ca, Cu, Fe, K, Mg, Mn, Ni, P, and Si.

Most interesting of all to the researcher are the components which are still unknown. Probably acetylocholin is present in honey. Dingemans discovered in 1938 the presence of the estrogen hormone and Oliver in 1940 the vegetal hormone. One of the most important biological substances of honey is inhibine. This subject was begun by the German scientists Dold and Witzenhausen[13] and has been a research project since by other French, Greek, and American scientists.

The Use of Honey in Modern Therapy

Undoubtedly, the therapeutic effect of honey originates from the chemical substances described previously, as well as from the components still unknown to science. This secretion which is a derivative of both the plant and animal worlds, was the sole sweetener known to men in antiquity and in the Middle Ages before the discovery of cane and beet sugars. Cane sugar is cheaper than honey and so in modern times, honey, a natural aid to good health has been lost to nutrition.

What is the source of this valuable nutritional effect of honey? First of all, the high percentage of monosaccharides, fructose and glucose, which are absorbed directly into the bloodstream without need of digestion. This absorption is so rapid that it is instantly efficacious to the human organism and, consequently, the feeling of fatigue disappears. This was proved in substance between the two World Wars by the German Army with the use of honey after long and trying marches. Alpine climbers in the Swiss Alps and American athletes after races also use honey to banish fatigue. This use of honey for the specific effect on fatigue by the ancient Greeks in their Olympic games and by the pugilists of Ancient Rome has been confirmed in present-day clinical research in both Europe and America. The facile and light absorption of honey serves as an excellent vehicle for other foods, drugs, and medicine by aiding the digestion of these substances. This has been established by the research of Phillips, Zaiss, Caillas, Kunitz and other well-known scientists. This fact also explains the use of honey in the many prescriptions of the Egyptian physicians, Galen, and Hippocrates. The light, appetizing quality of honey has been well known from ancient to modern times.

(*Continued on Page 120*)

WHY JULIUS SUMNER MILLER CAME TO CENCO WITH HIS NEW IDEA . . .

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Honey

(Continued from Page 118)

Honey in the Development of Infants and Children

Clinical research has shown that honey plays an important role in the feeding and development of infants and children. Schultz, Knott, et al observed that honey was absorbed into the bloodstream within fifteen minutes. Monosaccharides show the same rapidity of absorption. Clinical research also confirms the effect of honey on the assimilation of calcium.

The effectiveness of honey in infant feeding has been confirmed by varied research in several universities. Most interesting is the research of Vignec and Julia.[14] Subjects of their research were 387 infants and children from infancy through four years of age. Part of the group was fed dextromaltose and the other part of the group was fed honey. Those children fed with honey showed a decidedly better linear growth and a higher rate of hemoglobin than the control group. The researchers found that dark honeys produced better effect than light honeys.

Other clinical research confirms the beneficial feeding of a mixture of honey and milk in infant feeding. But this is a well-known beverage proposed even in ancient times by the Athenian philosophers and physicians who believed it would aid in prolonging life and which they named, "Ambrosia". Further research confirms the organic acid content of honey—the appetizing substance of honey. The laxative effect of honey in infant and child feeding as a preventive against constipation is also confirmed. The use of honey as a sedative and tranquilizer is disclosed also. Michaelis also used honey for various buccal and intestinal infections in pediatrics.

Honey in the Treatment of Diabetes

From publications of the United States Bureau of Vital Statistics in the last 50 years there has been an increase in deaths caused by diabetes. F. G. Banting, Canadian physician and discoverer of the insulin treatment for diabetes, has given a warning against the use of artificial sugars:

> In the U. S. A. the incidence of diabetes has increased proportionally with the per capita consumption of cane sugar. In the treating and recrystallization of the natural sugar cane, something is altered which leaves the refined product a dangerous foodstuff.[15]

Szent-Györgyi, discoverer of Vitamin C and Hungarian Nobel Prize winner, published excellent results from the treatment of acidosis of diabetics through peroral administration of succinic acid.[16] Many more renowned scientists determined the healing effect of various acids such as succinic, citric, malic, lactic in the treatment of diabetes. All of these acids are contained in honey. Consequently, many clinics and physicians use honey in some form in their treatment of diabetic cases. On the other hand, numerous physicians maintain that it is the various carbohydrates, fructose, melecitose, and dextrines which have a more beneficial effect in the treatment of diabetes. Again, all of these carbohydrates are present in honey. Melecitose is found primarily in honeydew honey. In America, the tupelo honey collected from the plant, Nyssa Aquatica, is another source for melecitose.

Honey in the Treatment of Anemia

Anemia is a quantitative deficiency of hemoglobin. Many scientists have studied the connection between the use of honey and an increase of hemoglobin. Rolleder in Austria, Koch, Theobald, and Zaiss in Germany, Johnson in Australia, Perez in Spain, and others, all found an increase in hemoglobin as the result of the use of honey. But the kind of honey is of considerable importance. Most researchers found that the dark honeys were decidedly more beneficial than the light honeys. Palmer and Tanquary in 1942 preferred heather honey as the best remedy for anemia. Other authors believed it was the mineral content of honey that caused the beneficial effect. Saiss asserted that iron was the responsible factor, but others believe that it is the manganese, copper or phosphorus content. All established, however, that the dark honeys were the most effective.

Honey in the Treatment of Stomach Ailments

The curative effect of honey in stomach disorders has been defined by many clinics and physicians. It is an established fact that ulcers have been retarded and halted in some cases by the histidine content of honey. Many scientists assumed that the estrogen hormone was a decided influence. Larizza and Paveri established that the estrogen hormone had very good effects in the treatment of lesions of the digestive tract.

Honey in the Treatment of Intestinal Infections

In honey, there are present small quantities of volatile substances. These have excellent effects on the peristalsis process (Meyer-Gottlieb). Spottel defined in honey an

anthracenic glucoside which results through hydrolysis or oxidation in an oxymethyl-anthraquinon which promotes elimination.

In my latest research, I have found that honey is a good regulator of the pH in the bladder. The same may be true in the intestinal tract. Opinions are divergent, however, on the question of whether this digestive process is caused by the activity of the diastase enzyme or by the presence of tannin. The enzyme amylase, if it is in a neutral or weak acidic medium, is very active in the intestinal tract.

Honey in the Treatment of Urinary Disorders

Honey, especially heather honey, has a decided diuretic effect caused primarily by the fructose but also to a lesser degree by the glucose content. Presently, biologists are examining the antibacterial properties of honey not only *in vitro* but also in the human organism. My research findings in the biological research laboratory at Duquesne University are presently being printed in part—further findings being yet incomplete.

Honey in the Treatment of Respiratory Infections

The antibacterial effect of honey in pharingo-laryngeal infections, especially, has been proved by several researchers. Inhibine exists, undoubtedly, but the complete composition of this substance is presently unknown. Inhibine also destroys different pathogenic bacteria found in the same region of the body.

Honey in External Applications

The healing effects of honey in infected wounds have been well known not only by the ancient physicians of Egypt, Greece, and Rome but are acknowledged in our present day. Zaiss, Dold, and Witzenhausen and many others confirm this fact by widespread research. Zaiss used honey with good results in the treatment of infections caused by Bacillus anthracis in an experiment where a preliminary incision was made in the infected zone. The cure was effected in twenty-four hours with the external application of honey being renewed several times.

Honey is also used in clinical practice for treatment of throat disorders, nose and tonsil infections, and for skin eczema.

Honey in Injections

For several years, the German Pharmacopoeia has used a prescription of an injectable honey preparation. The name of this preparation is Honey Woelm M2. It contains 20–40 percent honey which is ultrafiltered. I found and demon-

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strated with my collaborator S. Kominos[17] that inhibine, the substance which has the inhibitory effect is filtrable but *not* ultrafiltrable. So this preparation has the effect only of the monosaccharides. Here, however, we must note that the inhibitory effect is varied in different types of honey. German physicians report that injected honey causes a regression in the icterus, decongestion of the liver, and an increase in body weight.

Honey in Cutaneous Disorders

Honey has an antiprurigenous activity in cutaneous disorders similar to the effect of luminal or calcium gluconate.

Honey in Cardiac Therapy

Prevention is the key to cardiac treatment. A most detailed literature exists on the research of honey in heart therapy. In using honey, the patient's heart is spared work because the greatest percentage of honey is represented by the monosaccharides which absorb without any work by the heart. Chauvin has outlined the uses of honey in cardiac therapy, reporting after Schimert:

1. All insufficiencies of coronary with or without angina of the lungs, compensated or decompensated; honey alone suffices sometimes.
2. By all hypertonics, chiefly by essential hypertonic with increase of eretism sympathicotonic.
3. Myocarditis with alteration of the rhythm, postdisterial myocarditis.
4. As an adjuvant of therapeutics through the heterosides cardiotonics.
5. After a difficult operation as analeptic cardiac.[18]

Many physicians prefer a simple honey cure. Before bedtime, the patient drinks a half cupful of a honey-water solution

Honey and Infections Caused by Pathogenic Bacteria

The beneficial effect of the inhibine in honey against different pathogenic bacteria has presently been proved *in vitro*. Stolte[19] reported favorable antidiphtheria therapy. Pothman[20] obtained good results in tuberculosis therapy. Most interesting are the research findings of Feuerisls[20] and collaborators in antituberculosis therapy at the Research Institute of Tuberculosis in Prague, Czechoslovakia.

Conclusion

Ancient medicine, with little knowledge of the chemical or bacterial composition or the biological properties of honey, discovered empirically the therapeutic effects of this truly amazing substance.

Even today in America, the use of unpasteurized honey, along with apple cider vinegar, is the subject of a current best seller, "Folk Medicine", by Dr. D. C. Jarvis. Headlines were made in recent days by the pronouncements of Dr. Arthur S. Flemming, Secretary of Health, Education, and Welfare, concerning the effects of Dr. Jarvis's pseudoscientific writings.

... on the unwary and the uninformed, having read somewhere of the magic contained in a so-called health food, resort to selfdiagnosis and a serious medical problem remains unchecked.

(*Continued on Page 125*)

AO Reports on Teaching with the Microscope

A Short Course on Carassius auratus Hematal or who slipped Fin the Mickey

One of the most fascinating sights a student can observe in a biology course is the complex network of the blood circulatory system in action. Although the system may not be viewed in its entirety, the student is able to see a large enough portion, with the help of a microscope, to identify arteries, veins and capillaries...visually establish the particular function of each.

Subject for the experiment is a goldfish, picked for reasons which our author, Mr. Ted Stopyra, explains below. Observation medium for the experiment is the AO Spencer No. 66 Student Microscope which we have picked for what might at first seem selfish reasons...but realistically not so, when you consider that this is an instrument ideally suited for student microscopists.

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EXPERIMENT

Circulation of Blood

By: Ted Stopyra
Middletown High School
Middletown, Connecticut

To demonstrate blood in action a goldfish was selected over the frog for many reasons. Frogs pose a problem in keeping them alive for any length of time. The goldfish on the other hand can be kept alive indefinitely.

The problem of keeping and feeding the goldfish is a minor chore as compared to the frog. In addition, the anesthetizing, the maneuverability and transparency of the fish's fin far surpasses the web of the frog for this experiment.

MATERIALS AND PREPARATION

1. AO Spencer No. 66 Student Microscope
2. Lantern glass slide 3½" x 4¼"
3. Living goldfish (the Fantail or Common Comet species). Preferably two inches or more in body length.
4. Absorbent Cotton
5. Chloretone Crystals (Chlorobutanol-hydrous) 1 oz.
6. Pipette
7. Beaker of water
8. Cover slip

Fig. 1

Chloretone is mixed by adding one ounce of Chloretone crystals to eight ounces or 236 c. c. of water in an amber glass bottle. Shake the contents and let the solution stand. The chloretone solution keeps well even though the crystals are slightly soluble.

PROCEDURE:

1. To anesthetize the goldfish you place four ounces, or 118 c. c., of water in a beaker or wide rim container such as a mason jar. Then add one or two teaspoons of Chloretone solution to the water, stir and place goldfish into solution. In a few minutes the goldfish slows down and rolls over on its side. (Fig. 1) The fish will remain anesthetized for an hour or two.

2. When the fish obtains the side position, remove the fish from the Chloretone solution and wrap a layer of dripping wet absorbent cotton around its body and place on a lantern slide. It is best to saturate the cotton with water from the tank or container the goldfish came from originally. When covering the body with cotton, place it in such a way that the mouth is not covered and the posterior tail is exposed.

Fig. 2

3. Place the prepared slide under the microscope (Fig. 2) and focus under low power.

OBJECTIVE:

To provide a visual demonstration of blood circulation in a living animal containing a backbone.

1. Once the specimen is focused, one readily notices the movement of blood through the blood vessels. Arteries are identified by the flow of blood toward the fin. Veins on the other hand are recognized by the flow of blood toward the head. Connecting these vessels are hair-like structures called capillaries. Blood cells flow through these capillaries one at a time.

2. By changing the objective to 43x and adding a cover slip, the lymph vessels and capillaries become very clear. Lymph vessels are recognized by the slow rate of movement of corpuscles through them in comparison to the blood vessels.

3. To observe coagulation one just has to pierce the fin with a pin and thereby rupturing many capillaries.

Fig. 3

RECOVERY:

1. One method of reviving the fish is to put it in a pail of fresh water. Ordinarily it would swim off at once. However, this does not always happen. The preferred method is to subject the fish to artificial respiration. This is administered by holding the fish between two fingers and pushing it through the water rapidly. (Fig. 3)

Seldom does a fish fail to revive because the water is forced through the mouth and out the gills. A rapid motion introduces more oxygen to the gills, and the more oxygen absorbed the speedier the recovery.

The length of artificial respiration depends upon how long the fish was under the microscope. It is best to continue the use of artificial respiration until the fish swims out of one's fingers.

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New Books

Policies for Science Education

●*By* FREDERICK L. FITZPATRICK (Editor). Bureau of Publications, Teachers College, Columbia University, New York, 1960. Pp. X + 219. $3.95.

This monograph is a summary of the problems and trends in providing better science instruction at the different school levels. It seeks the answers needed to meet the post-sputnik warning that unless America gets top performance in science and technology through superior programs in science education, our nation will continue to "catch up" rather than "keep ahead" of our world competitors.

The first three chapters survey the need for science manpower, technologists and science education; the nature and functions of policy making, and existing programs and problems.

Chapters four and five deal with the improvement of teaching and administration. The following six chapters are concerned with the problems of science instruction at the elementary, junior and senior high school levels, followed by recommendations for the improvement of science education in teaching training.

There is no question of the great importance of this volume among the Science Manpower Project Monographs. Questions concerning the factors that account for success in learning science through effective programing and teaching, and how talented students in science can be identified and provided for are no longer academic. They relate directly and sharply to our national economy, security and defense capability as well as our international posture.

Francis X. Kleyle, Ph.D.

Head, Graduate Department
Professor of Elementary Education
Duquesne University

The Scientific American Book of Projects for the Amateur Scientists

• *By* C. L. STRONG. Simon and Schuster. New York. 1960. Pp. 584. $5.95

Readers of the *Scientific American* who are familiar with C. L. Strong's column will welcome this book. C. L. Strong's column is for the interested layman in science and presents projects and studies in almost every field of science. It presents projects in astronomy, archaeology, biology, earth sciences, mathematical machines, and several of the fields of physics. All have appeared in the pages of the *Scientific American*. Not only is the project described but enough of the basic theory behind the project is explained to enable the reader to understand its purpose.

This is an excellent book for an interested person seeking a hobby or for teachers or students who are seeking ideas for science projects. *J.P.M.*

Physics is Fun

• *By* GERHARD NIESE (Translated by Donald Iowa Mitchell). Astro-Computing Books. Washington, D. C. 1960. Pp. 150. $2.95.

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A History of the Theories of Aether and Electricity by SIR EDMUND WHITTAKER. Volume I: The Classical Theories (Pp. 428, $1.95). Volume II: The Modern Theories (Pp. 320, $1.85). This classic belongs in the library of every teacher of science and persons who have an intelligent interest in science.

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The Foundations of Arithmetic by GOTTLOB FREGE (Pp. 119, $1.25) is an excellent study of the nature of the concept number. It examines the views of many philosophers concerning the nature of number and the author develops his own views in a logical and scientific manner. This is a book for a philosopher or a philosophically inclined mathematician.

Concepts of Space by MAX JAMMER (Pp. 208, $1.40) is a history of the theories of space in physics. The metaphysical and theological speculations concerning the nature of space are also given consideration. The foreword is by Albert Einstein. A most interesting and well documented book.

Premier Book

The Exploration of Space by ARTHUR C. CLARKE (P. 192, $0.50). We recommend this well written and factually accurate book to high school students and also their teachers.

An Introduction

(*Continued from Page 101*)

metal (hafnium content does not affect the corrosion properties) should find a wide variety of applications in the chemical and allied industries. These same properties make it very suitable for surgical uses such as pins, screws and plates for bone repairs, suture wire and instruments. Undoubtedly, as the availability and properties of zirconium become better known, numerous applications will be found where its extraordinary resistance to chemical attack is required.

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Honey

(*Continued from Page 122*)

Without resorting to superstition or popular folklore, but based on the documented research findings of scientists in allied fields from many corners of the globe throughout the years, I have tried to outline the standpoint of modern science on the therapeutic value of honey as a medicine—not as a palliative or panacea, but as a substance that has earned a valid place in medical and pharmacological sciences.

Flemming, Jarvis, Galen, or Pythagoras—all would certainly agree with the Biblical advice given by the wisest of men, King Solomon:

My son, eat thou honey, for it is good.
Proverbs, 24:13

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* * * * *

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The fiction of Jules Verne is rapidly becoming fact as the world begins to adapt to a new "space age." Satellites are now in orbit. Sending a rocket to the moon is under active discussion. Outer space travel is sufficiently close for the conducting of military experiments to simulate its conditions.

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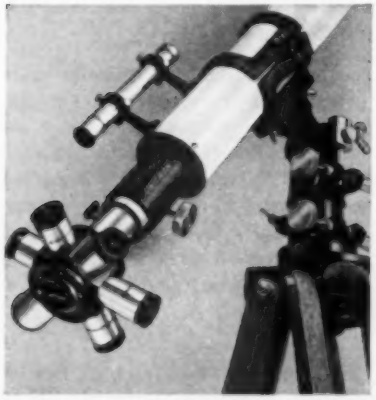

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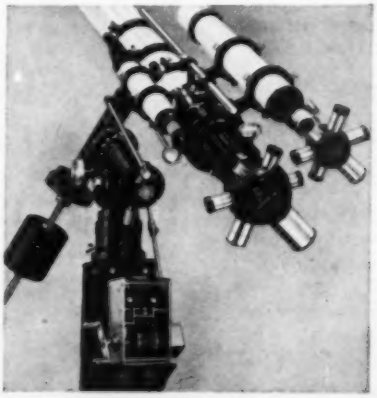

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Odenbach

(*Continued from Page 109*)

Tuesday, April 19, 1960, was a day of rejoicing for McQuaid seismologists, because that was the day we started to move our seismic recording instruments into our permanent recording room. Up to this time we had been using a very shaky wooden table with only a flimsy box over it to make it light tight. A few weeks later we had our own fully equipped darkroom when we installed the counter tops.

Ever since the end of March we had been working to complete the fourth and final phase, the painting and the adding of the finishing touches, such as the bulletin boards, the shelves, and the enclosure around the pier. After applying at least two coats of paint on all surfaces, and putting on umpteen finishing touches, the Odenbach Seismic Observatory was at last completed.

Through the countless hours of work put in by the students under the direction of their moderator and advisors, and the thousands of dollars worth of equipment, and many hours of time given by the benefactors, we were able to dedicate the Odenbach Seismic Observatory, a member of the Jesuit Seismological Association, on June 12, 1960.

How the Seismograph Station Works

When an earthquake occurs, it sends out pulsating waves through the earth. The concrete pillar sunk into the ground intercepts these waves and is moved to a slight extent by them.

On top of this pillar is an instrument designed to detect these slight movements, called a seismometer. This seismometer consists of a horizontal pendulum, suspended by think flexible strips of gold. On the end of this pendulum is a coil composed of many turns of very fine wire. Attached to the base of the seismometer are two powerful magnets, one above and the other below the coil of wire.

When the pillar moves in response to the seismic waves striking it, the base of the seismometer moves with it. The pendulum of the seismometer, since it is free to move, remains in its original position because of its inertia.

The resultant movement of the magnets past the coil on the end of the pendulum creates a minute current on it, which is transmitted through wires to the galvanometer.

In the galvanometer, a small coil of thin wire is suspended between the poles of a permanent magnet by a very thin gold wire. A small round mirror is attached to the top of this coil, and another gold wire is attached to the bottom of the coil.

When the current from the seismometer passes through the coil by means of the gold wires, it creates a magnetic field around the coil. This magnetic field tends to align its lines of force with those of the permanent magnet surrounding it. In doing so its twists on the gold wire suspending it until the torque of the suspension system increases to the point where it is equal and opposite to the force the coil is exerting. This twisting is therefore dependent upon the amount of current supplied to the coil. The amount of current sent from the seismometer depends upon the amount of movement of the seismometer magnets. The amount of the movement of the magnets is determined by the strength of the seismic waves. Their intensities are related to the distance and the strength of the tremor.

A light source, which consists of a 6-volt taillight lamp in a brass tube, projects its beam through a 45° prism and out through a narrow slit in the side of the tube.

This beam of light shines on the mirror in the galvanometer, which reflects it. The beam is focused through a lens and is projected onto a piece of photographic paper wrapped around a large drum, 36 inches in circumference.

This drum is driven by an electric motor and as it rotates it moves down a spiral worm gear, so that as the drum moves beneath the beam of light, it creates a series of lines on the strip of photographic paper.

Since we will want some reference points to determine at exactly what time the wave struck the pillar, a small coil is placed beneath the metal plate behind the prism in the light source. Once a minute a specially-designed clock sends a pulse through this coil, moving the prism in the light source. This in turn moves the light beam hitting the galvanometer, thereby moving the beam reflected from the galvanometer to the photographic paper on the drum. The resulting jog in the line on the paper gives us an accurate idea of the time at which the wave was received.

Therefore, when a seismic disturbance occurs, it sends out waves which strike the base of the pillar, causing it to move and thereby generating a weak current in the seismometer, which is carried to the galvanometer, which, by moving its mirror and thereby deflecting the beam of light hitting it, records the movement of the pillar on a strip of photographic paper, which can be developed and examined.

Since we want to know the direction from which the seismic waves came, as well as the distance of the source, so that the exact location of the source of the disturbance can be pinpointed, two seismometers, at right angles to each other, are used. When a wave comes in, it will affect one seismometer more than the other, and by analyzing the results of the recordings by the two seismometers it is possible to determine the direction from which the waves came.

When an earthquake occurs, it sends out two different kinds of waves: longitudinal waves, which travel at relatively high speeds through the earth; and the transverse waves, which are relatively slow moving. Since the rates of these two different types of waves are well known, by computing the time lag between the arrival of the first and of the second wave, we can figure out the distance of the source from the observatory. Then, since we know both the direction and the distance, the exact location of the disturbance can be found.

* * *

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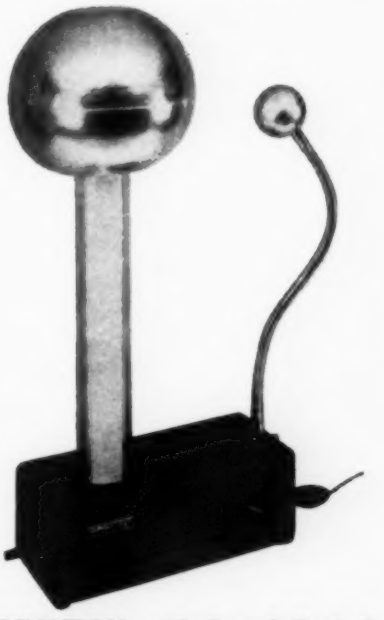

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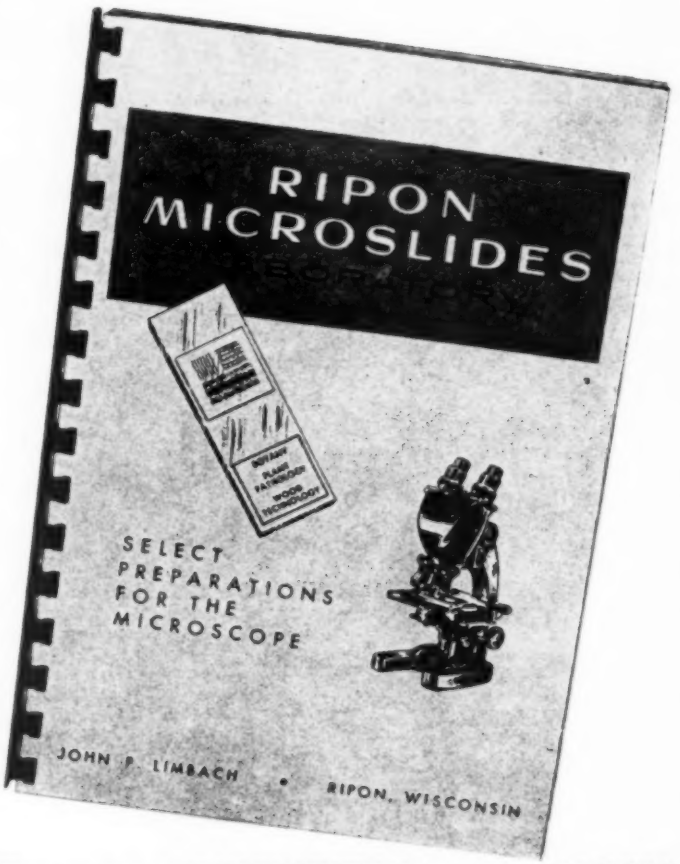

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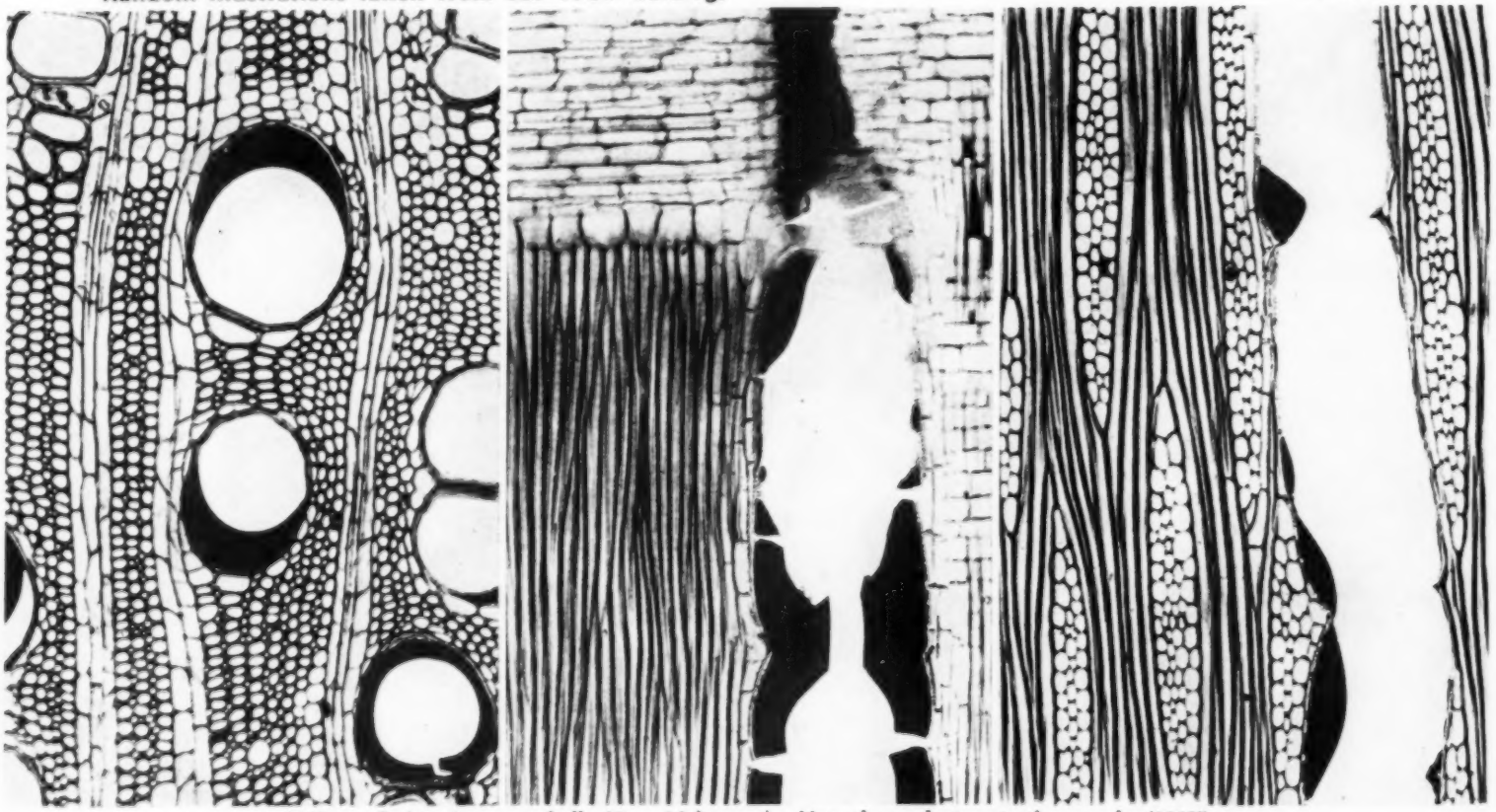

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City ..... Zone ..... State .....